

April 23, 1946.

W. W. MOUNT

2,399,136

ORDNANCE

Filed Feb. 17, 1943

3 Sheets-Sheet 1



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BY

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April 23, 1946.

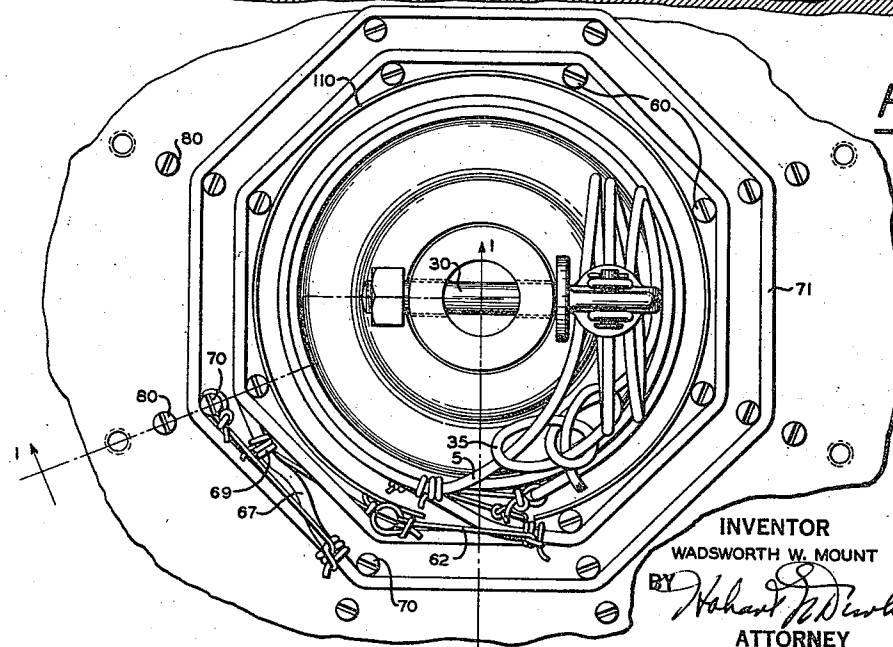
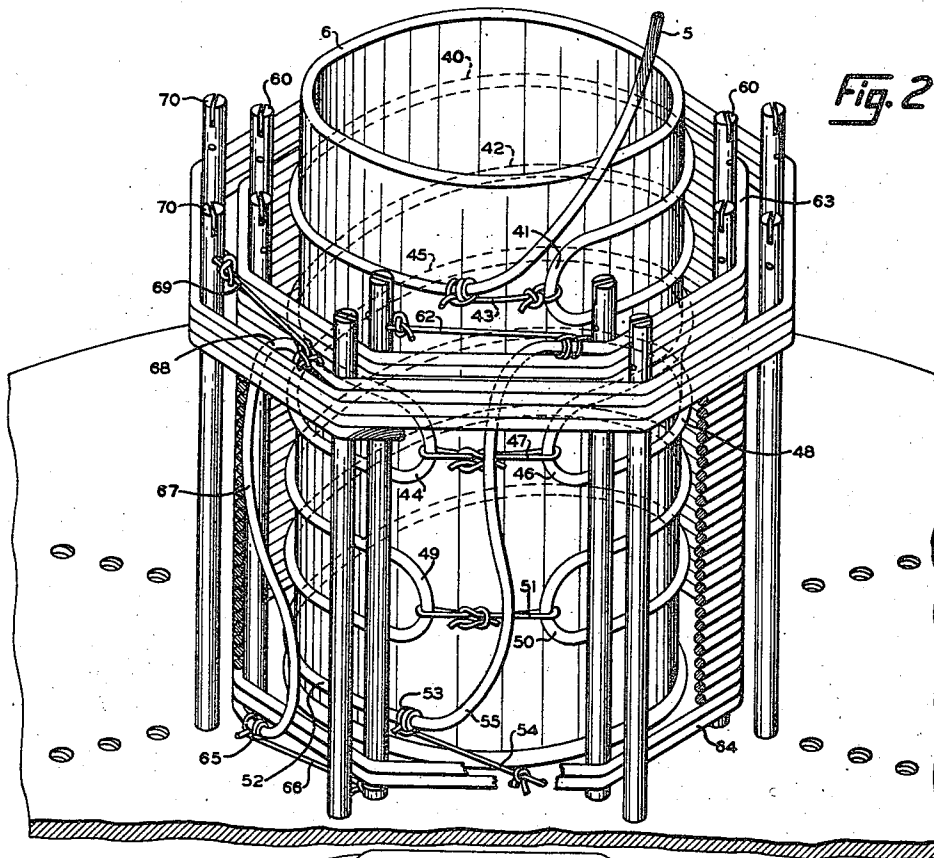
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3 Sheets-Sheet 2



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3 Sheets-Sheet 3

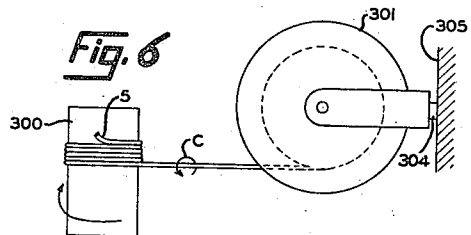
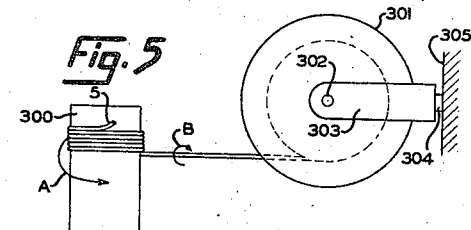
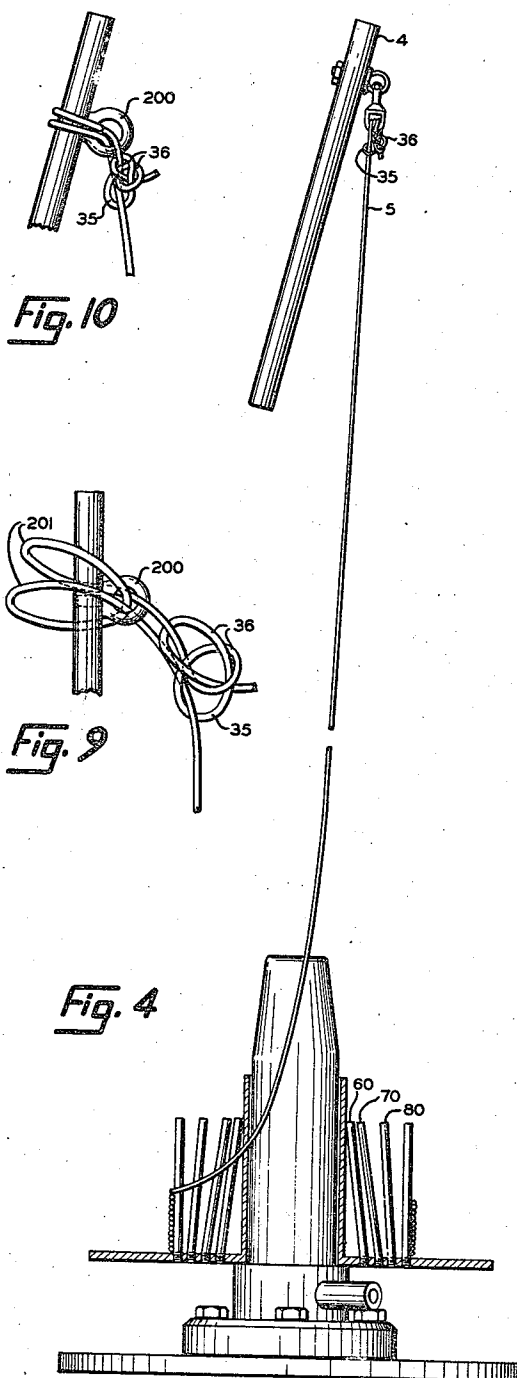
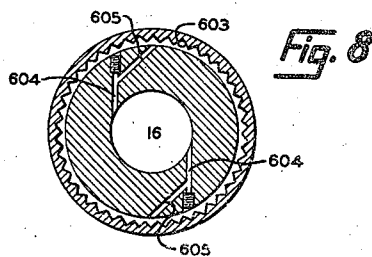
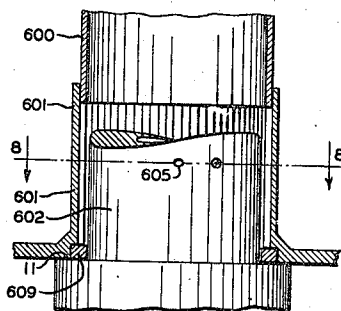


Fig. 7



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UNITED STATES PATENT OFFICE

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ORDNANCE

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19 Claims. (Cl. 89—1)

The invention relates to ordnance and more particularly to a novel gun and means associated therewith for projecting a cable or other filar projectile.

Objects and advantages of the invention will be set forth in part hereinafter and in part will be obvious herefrom, or may be learned by practice with the invention, the same being realized and attained by means of the instrumentalities and combinations pointed out in the appended claims.

The invention consists in the novel parts, constructions, arrangements, combinations and improvements herein shown and described.

The accompanying drawings, referred to herein and constituting a part hereof, illustrate one embodiment of the invention, and together with the description, serve to explain the principles of the invention.

Of the drawings:

Fig. 1 is a vertical front elevation of a weapon embodying the invention, one half being shown in section taken on line 1—1 of Fig. 3;

Fig. 2 is an enlarged fragmentary perspective of a portion of a cable reel, illustrating the method of winding on and attaching the cable;

Fig. 3 is a top plan view of the construction shown in Fig. 2;

Fig. 4 is a reduced front elevation, partially diagrammatic, and in part shown in section, of the weapon in operation;

Fig. 5 and Fig. 6 are diagrammatic views illustrating methods of putting a preliminary twist into the cable;

Fig. 7 is a fragmentary detail, in vertical section, of a modified construction for imparting preliminary rotation to the cable reel;

Fig. 8 is a horizontal section on line 8—8 of Fig. 7;

Fig. 9 is a fragmentary detail, in elevation, of a projectile showing a modified attachment of cable thereto; and

Fig. 10 is a view similar to Fig. 9, showing the condition after firing.

The invention is directed to providing a novel and effective weapon primarily for defense against low flying aircraft, being particularly effective against airplanes flying at such low elevations and high speeds that usual defensive armament such as machine guns and other automatic or rapid-fire weapons are relatively ineffective.

A principal object of the invention is to present and maintain an obstruction in the path of an airplane for a substantial interval in time and space, said obstruction being designed to impede

the course of the plane, throw it out of balance, entangle its controls and propellers, break or sever wings and other flying surfaces and otherwise damage the aircraft by the effects of collision with said obstruction. The obstruction preferably employed is a length of steel cable or other strong filar material which is projected into and maintained in the path of the oncoming aircraft for a sufficient time to insure collision. The damaging effect of the obstructing cable or the like is, in accordance with the invention, greatly enhanced by means which weight or anchor both ends of the projected cable so that the full tensile strength thereof is exerted against the contacting and impacting surfaces of the aircraft, thus making the damaging effect of the obstruction far greater than that of a freely suspended cable of the familiar parachute type. For this purpose the free or leading end of the cable is attached to a relatively heavy projectile which is fired from the gun and draws the cable after it, while the other or trailing end of the cable is fixed to a heavy object adjacent the gun so that while the cable is across the path of the aircraft, both ends thereof are relatively immobilized and thereby the cable is under a substantial inertia and imparts its full tensile strength to the contacting aircraft. This inertia is exerted from both ends of the projected cable so that the tendency thereof is to loop about the aircraft and exert a substantial drag and, at the same time, a sawing or cutting action thereon. However, the ends of the cable are preferably not fixed to any immovable object so that the cable will not snap or be stressed beyond its tensile strength limits when struck by the aircraft, at least until that tensile strength has been fully exerted against the aircraft. In this connection the length of cable projected into the air is preferably less than the total supply thereof, thereby maintaining a reserve of unexpended cable at the firing point, against which the initial tug of the ensnared aircraft must first be exerted. This arrangement provides a cushioning effect on the terminal part of the cable, avoiding a sudden sharp tug thereof against the weight to which it is connected at the bottom.

The invention is designed to project the cable for a relatively long distance into the air from a fixed base at the ground, said distance preferably being several times greater than the altitude of the plane that it is intended to ensnare. Thus the period of time during which such a cable may be maintained across the path of an oncoming

plane is relatively long and consequently the necessity for accurate fire-control calculations and application of lead factors and corrections for wind, drift and other ballistic factors is greatly reduced in comparison to such factors affecting the fire control of usual anti-aircraft weapons. Preferably the cable and its projectile are fired practically vertically upward, and this manner of use avoids the necessity of accurate aiming and directing of the gun at the time it is fired. A plane in low-level bombing, or strafing, attacks, must necessarily travel in a fairly straight line so that at some point its wing spread crosses a vertical line directly above the objects being attacked. This feature enables the gun to be fired from a distant control point where the intersection of an oncoming plane with the cable to be projected can be observed from a remote position and thereby, with some practice, the timing of the firing of the gun to ensnare an oncoming plane can be a matter of accurate performance for a target of any observed altitude and angle of approach. Moreover because of the preferred method of firing from remote positions, either by manual or electrical means, a plurality of guns may be controlled by a central or otherwise appropriately located operator who may be so placed as to see and observe the oncoming planes a substantial time prior to when they would come into the normal view of personnel located at the guns or at the point to be protected thereby. Obviously also in many cases safety of personnel is enhanced by the ability to control and fire the gun from a remote point.

The invention is also capable of automatic operation in certain locations and military situations and for such purpose may be electrically fired by automatic plane-detecting means spaced from the gun or guns in loci below expected avenues of approach of hostile planes. Electronic plane detectors, such as photo-electric or "radar" devices may be so positioned so as to automatically fire the gun when the plane has come within a predetermined proximity thereof. Similarly audio-operated control means may be provided for firing the gun when the sound of an approaching plane has reached a predetermined volume or intensity.

In providing a weapon designed and capacitated to operate as aforesaid, the invention also provides many novel and useful means and devices for effecting the most efficient functioning of such weapon. Among the major objects of the invention in this respect are the provision of means for preventing breakage of cable or separation thereof from the projectile at the time of firing due to the great acceleration generated at the moment of firing; and means for preventing a twisting and entanglement of the cable with itself and other objects adjacent to it and around the gun. The latter means include many novel elements of construction with respect to the initial winding of the cable and attachment thereof to the projectile and to the mechanism or reel for holding the cable while same is being projected. In the conception and perfection of such devices lies much of the novelty and superiority of the invention because thereby I am enabled to project a relatively great length of cable rapidly, cleanly and without kinking, twisting or other action tending to weaken the cable; using for the projecting means an exceedingly simple, inexpensive, light, portable weapon of comparative low muzzle velocity.

It will be understood that the foregoing gen-

eral description and the following detailed description as well are exemplary and explanatory but are not restrictive of the invention. Referring now in detail to the present preferred embodiment of the invention, same is illustrated by means of the accompanying drawings. As shown in Fig. 1, the invention comprises the following principal devices: a smooth bore gun of the muzzle-loading type having a vertically-disposed barrel 1, an integral base ring 2 and a large diameter disc-shaped base plate 3; a projectile 4, the upper end of which protrudes from the muzzle of the gun and to which is attached the leading end of the cable 5; a freely rotatable reel on which the cable is wound in concentric cylindrical layers from the central portion of the reel outwardly, said reel comprising a central tube 6 concentric with and sleeved about the outer surface of the gun barrel 1, a horizontally-disposed annular reel plate or disc 7 at the bottom of the reel tube 6 and rotatably supported with respect to the gun barrel, and a plurality of concentric circles of winding pins 8, having their lower ends fixed in the reel plate and projecting vertically upwardly therefrom, about which the cable is wound as aforesaid. The above-described general features of the invention will now be described in detail.

Referring first to the construction of the gun, the base plate 3 thereof is attached to the base ring 2 by a plurality of angularly-spaced bolts 10. The gun barrel projects vertically upwardly from the base ring 2 and the external diameter thereof is reduced at 11 to form an annular shoulder which acts as a support for rotary bearing for the reel plate 7, upon which the reel may rotate freely. If desired, a different form of rotary support between the reel and the gun may be provided by spaced-apart roller members (not shown) mounted on the base plate 3 or on the base ring 2 and supporting the underside of the reel plate 7 nearer the periphery. Above the shoulder 11 the portion 12 of the barrel is cylindrical both externally and internally for a height in the neighborhood of the upper edge of the reel tube 6. Thence the external surface of the barrel tapers upwardly to form the frusto-conical nose portion 13. The bore 14 of the gun is smooth and cylindrical, terminating at the closed breech end 15 as shown. Any suitable firing mechanism may be provided adjacent the breech end of the bore, which portion thereof acts as the firing chamber for the propellant shown as the powder bag 16. The propellant is preferably spaced from the breech end 15 of the bore by a suitable spacer 17 which may be formed as a grid of wire or similar open material. As shown, the firing mechanism is that conventionally used with the so-called Lyle gun for firing life lines and comprises the tubular member 20 communicating with a vent from the powder chamber and being adapted to house a suitable percussion-operated cap or cartridge which is fired by a spring-actuated pin 21, the latter being released by a cocking piece 22 suitably connected to a lanyard 23 for operation from any desired distance. Details of this firing attachment may be found in a publication of the U. S. Coast Guard thereon, dated October 1, 1936, and entitled "Firing attachment Lyle line-throwing gun."

It will be understood that the firing mechanism here shown and described is a conventional device forming no specific or essential element of the invention, as any other suitable form of firing or propellant igniting means may be provided

and in many cases it may be desired to use electrically operated or controlled firing means, of which there are numerous known and suitable types.

The projectile 4 may be of any suitable form and shape for the purpose intended. As shown it comprises a relatively long cylindrical bar having an external diameter slightly less than that of the bore 14 of the gun and when inserted in the gun as shown in Fig. 1 the lower end of said projectile is adapted to rest on the upper end of the powder bag 16, being preferably spaced therefrom by a gas-check pad 25 of asbestos or other suitable fibrous material of a diameter such that it fits tightly against the wall of the bore. As shown the projectile is tubular or hollow throughout a considerable portion of its length, this bore 26 being provided to reduce the weight of the projectile and, if desired, as a chamber for explosive, smoke-producing substance or other material. Depending, however, upon the material of which the projectile is made, the amount of propellant used and the ballistic qualities desired, the length and diameter of said bore 26 may be varied or same may be eliminated as conditions may require. As will be clear from the drawing the length of the projectile 4 is such that a substantial portion thereof extends beyond the muzzle of the gun, thereby to permit attachment of the cable to the projectile while same is seated in the gun in position for firing.

In accordance with the invention the attachment of the cable to the projectile is such that the cable will not be suddenly snapped, kinked or twisted either at the moment of firing or at any time during the travel of the cable and projectile through the air or after it has been hit by a plane. For this purpose the cable may be connected to the extending part of the projectile by means which permit complete universality of movement of the projectile with respect to the cable, so that no matter how the projectile may twist or turn in its flight and upon contact with aircraft or other objects, the cable will remain untwisted and hang free from its point of connection with the projectile. In accordance with this principle an eye bolt having a shaft 30 and eye 31 is disposed diametrically through the projectile near the upper end thereof, the aperture through which said bolt extends being large enough to permit free rotation of the bolt on its own axis. An anchor swivel comprising the U-shaped stem portion 32 is loosely and rotatably linked through the eye 31 by clevis pin 33. The other end of the swivel comprises an eye 34 which is rotatably sleeved on the projecting end of the stem 32. Said eye 34 is of a size and shape for attachment thereto of the end of the cable as hereinafter described.

In accordance with the invention the free end of the cable 5 is attached to the swivel eye 34 in such manner that the sudden impact and acceleration of firing the projectile will not overstress and snap the cable. Accordingly the attachment of the cable to the anchor swivel is initially made by providing a substantial amount of slack which is taken up relatively gradually as the projectile leaves the gun under the acceleration of firing. In the preferred form of attachment, a loop or bight 35 is formed in the free end of the cable, said loop being held against slipping or constricting by means of a non-slip knot such as the bowline knot 36. Beyond the loop and bowline the cable is preferably looped or festooned loosely in a plurality of turns 37

through the eye 34 of the anchor swivel and thence the depending length of the cable 5 passes through the fixed loop 35 as shown. In order to prevent entanglement of the loops 37 with each other and with the adjacent devices, same are preferably spaced from each other within the anchor swivel 34 as by thin spacing members or washers 38. Preferably all parts of the cable and projectile hereinabove described are greased or lubricated so that they will slide easily and loosely with respect to each other and are usually tied or bound in position by breakable bindings such as string, tape, cardboard sleeve, etc., not shown.

Upon firing of the projectile, the slack in the attached portion of the cable is taken up and the cable is drawn fairly tightly up against the anchor swivel and into the position shown in Fig. 4. It will be noted that the loop 35 is not constricted although the bowline knot 36 is itself tightened up as well as the other slack parts between the loop 35 and the anchor swivel.

A modified form of attachment of the cable to the projectile is illustrated in Figs. 9 and 10. As shown in Fig. 9 the cable may be looped one or more times about the body of the projectile itself and in such arrangement the tendency to snap the cable is reduced because the interposition of the projectile prevents constriction of the cable into an arc or kink of critical breaking radius. Accordingly, in Figs. 9 and 10 there is shown a relatively simple method of attachment wherein an eye bolt 200 is non-rotatably fixed projecting through the projectile near the upper end thereof. The cable is passed through a loop 35 and bowline 36 as previously described, but the intervening parts of the cable are passed through the eye of the bolt 200 and thence in multiple loose loops 201 over the end of the projectile to then encircle loosely the projectile adjacent the eye bolt. These loose loops 201 are drawn up to radii small enough so that they will not back off over the upper end of the projectile in their loosened state. Upon firing, the loops 201 are tightened up around the body of the projectile as shown in Fig. 10, all without introducing critical stresses in any part of the cable. This form of attachment is especially effective when relatively large diameter cable is used.

I shall now describe the present preferred means for arranging and winding the bulk of the cable about the gun so that same may be readily paid off by the pull of the projectile, all without twisting or snaring or entangling of the unwinding cable and while affording the minimum of friction and retarding effect during the unwinding thereof and especially during the early part of the projectile's flight. In accordance with the invention the first few feet of the lead portion of the cable 5 below the bowline loop 35 are fairly loosely wrapped back and forth over the cylindrical surface of the reel tube 6. Said wrapping preferably is in the form of festooned loops, starting at the upper end of the tube 6 and working down toward the bottom thereof. This initial disposition of the cable is very important in that it reduces initial stress on the cable to the minimum, giving a loose and easily pulled length of cable which has virtually no resistance and thus enables the projectile to leave the gun readily and without any deflection from its intended course. The first stress is largely taken up by the contraction of the knot 36 and loops 37, which causes the cable to become firmly attached to the projectile, because the next following length, about the reel tube

6, is so readily released that when pulled out it exerts no friction, binding or cutting against the tube walls or the gun and also assures that no breaking force will be exerted against the cable being drawn off during that critical period of the firing. All this contributes to the desired action of taking up the firing load on the cable gradually and without weakening the cable.

As clearly shown in Fig. 2 the depending portion 5 of the cable is first wrapped in a course 40 around the tube 6 in clockwise direction to a point 41 where it is doubled under and looped backwardly in the reverse direction to form the lower course 42. The central point of the loop 41 is preferably disposed at about the level of the beginning of the course 40 and the center of the loop 41 is tied to the beginning of said course 40 by a piece of string or other easily frangible connecting means 43, thereby holding the first two courses in position. It will be noted that the end of the loop 41 does not quite reach the course 40 nor the depending length 5 of the cable. The lower course 42 is continued around in counter-clockwise direction to a loop 44, the point of which is substantially vertically below the beginning of course 40. The lower course 45 formed by said loop 44 is drawn in the reverse or clockwise direction about the tube to form the upper part of the opposite loop 46 so that the two loops 44 and 46 are opposite each other and are joined by a frangible connection such as the piece of string 47. In suitable manner the lower course 48 of the loop 46 is drawn counter-clockwise around the tube to form the lower loop 49 which in turn is attached to the next opposite loop 50 by the connecting string 51. In similar manner the entire tube is wrapped with loopings or festoonings of the cable until the bottom course 52 is formed. When same reaches the point 53 in line with the superposed loops 44, 49, etc., it is fastened in that position by a string 54, the opposite end of which is tied to the reel plate 7 through suitable holes therein. All of said string connections are preferably formed of relatively weak material which will break readily upon the upward jerk of the fired projectile but are of sufficient strength to hold the wound cable in place and for this purpose the knots formed in said pieces of string are preferably of a non-slip variety. From the point 53 the cable is drawn upwardly in the substantially vertical course 55 between the opposed loops 49 and 50, 44 and 46, etc., on the outside of the string connections thereof.

The next step in arranging the cable is the wrapping of same cylindrically around the innermost circle of winding pins 8. Said inner circle of pins, indicated by the numeral 60, are preferably at least eight in number, equally spaced radially and circumferentially about the center of the gun. As shown, each of said pins is threaded at its lower end and screwed into an appropriate tapped hole in the reel plate, the upper end of the pin being slotted or otherwise designed for ready turning of the pin to seat and unseat it in the plate. All of said pins are preferably of equal height, all being substantially lower than the top of the inner reel tube 6. Each of said pins is also provided with a string tie hole 61 which passes transversely through the pin near the upper end thereof. The tops of the pins are made as smooth and free from burrs as possible, and preferably may be slightly rounded, thereby to avoid chafing or cutting wires of the cable as it passes over them.

In winding the cable about said inner circle of pins 60 I start wrapping at the upper end thereof, beginning with the top portion of the uprising course 55, the upper end of which is held in position by string piece 62 tied to the adjacent left-hand pin 60 (Fig. 2). The cable is then wound in counter-clockwise direction over each of the inner pins 60 in a substantially horizontal course and thence again around said circle of pins just below said first course and so on to form a substantially cylindrical or octagonal wall of successive contiguous horizontal courses from the top course 63 to the bottom course 64. The lowermost course 64 terminates at point 65 where it is attached by string 66 to the next adjoining pin 60 near the bottom thereof.

Thence the cable is bent upwardly to form the loose rising course 67 which passes outside the wall of cable about the pins 60 and at its upper end 68 is connected by string 69 to an adjacent pin of the next outer circle 70 thereof. The cable is then laid counter-clockwise about the pins 70 beginning with the uppermost course 71 and on down again to the bottom as before, thus forming a second wall of cable windings about the pins 70 from top to bottom thereof. In like manner the lowermost course of cable about the pin 70 is brought upwardly and outwardly to be held with suitable string fastenings and wrapped in a third wall about the circle of pins 80; and so on until all the cable is wound in successively greater-radius cylinders formed and separated from each other by the concentric circles of pins (Fig. 1). The terminal course 101 of the entire reel of cable is preferably fixed to the reel plate and as shown is knotted or looped through the three openings 102, 103 and 104 therein to form a terminal knot or non-slip anchorage 105 thereat.

The cable preferably used is made up of a plurality of strands, each strand comprising a plurality of twisted steel wires. For general purposes I have found that a $\frac{3}{4}$ " diameter, 6 x 7 (six strands of seven wires each), cotton center, standard aircraft cord is suitable. Such cable has a tensile breaking strength of approximately 1000 lbs. In addition to its strength and general serviceability, it should be noted that such a cable has a substantial abrasive effect when in motion past a surface, so that when a part of an airplane comes in contact therewith there will be an effective sawing action of the cable upon the plane due to the vertical up or down movement of the cable in flight.

With the gun as shown, using the above-described cable and a projectile weighing approximately 5 lbs., same will lift approximately 500 ft. of cable vertically, using a 2 oz. black powder charge. The muzzle velocity of the projectile in such firing is approximately 530 ft. per second and the projectile is in the air approximately 10 seconds.

The invention is not limited to the use of this specific size cable, and where desired a heavier cable may be used such, for example, a $\frac{1}{4}$ " steel cable which has a breaking strength of approximately 5000 lbs. The height to which that or any cable may be projected will depend upon many ballistic factors, including the powder charge used, the relation of the weight of the projectile to that of the cable, etc.

Means (Figs. 1 and 3) are preferably provided for preventing entanglement, during firing, between the festooned courses of cable 40-52 about the reel tube 6 and those courses of the cable in

the next adjacent wall thereof on the pins 60, it frequently happening that the initial tug of the projectile jerks the looped parts of the cable so violently that they fly radially outwardly toward the pins 60. To prevent such entanglement a shield 110 formed of a flat piece of light metal curved to form an incomplete cylinder between the pins 60 and the festooned cable about the reel tube is positioned as shown in Figs. 1 and 3. The tendency of said shield is to expand outwardly and thus bear against the pins 60 where it protects said pins and the cable wound thereon from being struck by and ensnared with the rapidly disengaging loops 40—52.

In operation the firing of the projectile draws the attached lead portion of the cable upwardly therewith as indicated in Fig. 4. As there shown the cable has been pulled over the inner circular rows of pins 60, 70, etc. and it will be noted that those pins are shown as having been bent at their tops from their original upright positions inwardly toward the center of the reel, that bending being greatest as to the pins of the innermost row or circle and diminishing outwardly until a point is reached where there is virtually no inward deflection of said pins. This pin-bending action is a result of the manner in which force is transmitted from the projectile in flight to cable being drawn from the cylindrically wound walls thereof on the reel. For ease of unreeling it would be preferable to have the cable wound about a conical surface from the apex downwardly. However, if wound in such conical form, the tendency of each lower coil of cable would be to work outwardly and upwardly over the narrower coils above it because the tension exerted in winding the cable about the cone acts to force it upwardly along the inclined surface of that cone. In winding on a cylindrical surface, however, the vertical walls have no inclination and hence the tension on each coil of cable tends to hold it in place. I have therefore found that the cable must be wound on a cylindrical surface in order for the coils to stay in place during unreeling and also during storage and shipment. In the latter situations the expansive and contracting effects of temperature alone would cause serious disarray of the cable if wound on a conical surface.

However, under the upward pull of the projectile on a cylindrically wound coil of cable the tension of that pull is exerted along the length of the cable, causing the reel to turn and also tending to constrict the next coil or coils to a narrower diameter. It is this constricting pull which, exerted in the upper layers of the wound cable, causes the pins to bend as shown. The strength and resiliency of those pins is such that they bend inwardly at the top enough to form a somewhat conical surface as the cable pays off, thus releasing same without too much resistance yet gradually cushioning the tension of the pull upon the cable as a whole and the pull of the cable on the reel, so that the cable does not snap as it picks up its resistance load gradually. Thus the cable actually is wound on a cylinder but pays off in a cone, on the inner two rows of pins particularly, the cone being formed by the bending in of the pins as determined largely by the pull of the cable and the resistance of the reel and pins to that pull. The upward taper 13 of the gun facilitates clearance of the cable, especially the innermost courses thereof, as the part of the barrel above the reel tube 6 becomes part of the apex of the cone formed by the inward bending of the tops of the inner rows of pins.

Due also to the pull on the cable, there is a tangentially applied rotational force which rapidly causes the reel to rotate in the direction of the pull. This rotational force is applied to the reel through the constricting of the cable on the pins and on that portion of the reel tube 6 which is above the tops of the pins. This freedom of the reel to rotate as the cable unwinds is of great importance in effecting proper unwinding thereof. As the reel picks up speed, the cable tends to feed off with less and less constricting action on the coils thereof because the rotation counteracts the tendency to constrict. Consequently the tendency to bend the pins inwardly diminishes as the outer rows of pins are reached so that ultimately the cable feeds off those rows of pins with practically no constriction or inward pull and therefore without any bending effected upon said pins. Naturally also as the projectile rises in the air toward its maximum ordinate, the upward speed thereof diminishes so that the cable on the outer rows of pins is pulled less violently by the projectile.

It will also be apparent that the ability of the reel to rotate in the direction of pull greatly reduces the resistance to that pull and therefore results in the projectile being able to pull off a much greater length of cable than it could from a stationary supply. Also, as the projectile rises the horizontal centerwise component of its pull diminishes; moreover, the centrifugal action exerted on the outer walls of cable on the rotating reel may further contribute to the diminution of the centerwise pull.

The construction of the reel and its pins, as shown and described, is also of value and importance in the matters of supply and reuse, especially in the field. The bent pins may be readily withdrawn from the reel and new or straightened pins used to rewind and use over again the same cable or cable from a fresh supply. The use of pins as shown, which are relatively free to flex at their upper ends, is also helpful in storage of the cable which tends to lengthen and shorten upon temperature changes. Under such changes these flexible pins can give enough to adapt themselves without permanent distortion of the pins or the set of the cable, which might happen if the pins were rigid at both ends.

By the method of winding shown and described the cable is readily handled and loaded for firing. The weight of the reel with its pins and cable is sufficient to keep it from jumping off the gun barrel as the cable is pulled off by the projectile. As the force exerted in lifting the cable's weight and starting the reel turning is applied to the cable smoothly and without sudden shock, due to the yielding of the pins, the upward taper 13 of the gun, the lubricants, the rotatability of the reel and other factors, the cable is able to stand the stress, pay out cleanly and retain its full tensile strength.

I have found in practice that an axial twist is introduced into the leading portion of the cylindrically wound part of the cable when same is fired by means of the apparatus hereinabove described. It appears that so long as the reel is substantially stationary, the unwinding of the circularly coiled cable from the stationary reel introduces a twist therein, but that after the reel reaches a certain rotational speed, the rotation thereof counteracts the twisting of the cable and the remaining unwinding of the cable during the firing is without damaging twist. A substantial amount of twist in the cable is undesirable, es-

pecially at the start, as it greatly weakens same and introduces a tendency to kink. In accordance with one feature of the invention, therefore, I apply a preliminary reverse twist in that part of the cable which is wound around the inner row or rows of the reel so that the undesirable twisting action will be counteracted by the reverse twist formed therein and that portion of the cable will pay off sufficiently straight and untwisted in the firing. By having the reverse twist throughout that leading part of the cable up to that point where a substantial rotation of the reel takes place, all damaging twisting and the consequent evil effects thereof can be avoided. In the present construction I have found it sufficient to reversely twist that portion of the cable forming the cylindrical layer coiled about the inner circle of pins 60, although the exact point where the twist may be safely discontinued is not definitely known and depends somewhat on the muzzle velocity, length of cable already paid out, and other factors relating to the rotation of the reel. The swivel connection of the cable to the projectile also helps to relieve some of the twist in the cable when same is transmitted along the cable to the swivel in flight.

In Figs. 5 and 6 I show, diagrammatically, means for introducing said reverse twist into the cable. As shown, the cylindrical member 300 diagrammatically represents the winding surface of the inner circle of pins 60 about which the cable 5 is being wound by counter-clockwise turning of said cylinder as indicated by the arrow A. For such winding on of the cable it is necessary to introduce an axial twist or turn of 360° for each 360° layer of cable wrapped about the cylinder 300. The diagrammatically shown means for applying said twisting to the cable comprises a supply reel 301 from which the cable being wound is paid off. Said reel is mounted for axial rotation on a stub shaft 302 which is supported by a bracket arm 303. Said arm 303 is itself rotatable axially so as to turn the reel 301 end-for-end about a supporting axle 304 which projects from a wall support 305. By this construction (diagrammatically shown) the reel may be turned end-for-end as it pays out the cable being wrapped about the cylinder 300 and in so doing an axial twist in the direction of the arrow B is imparted to the cable during winding. If the cable is wound on to cylinder 300 by clockwise rotation thereof (Fig. 6) the cable must be twisted axially in the opposite sense as indicated by the arrow C and, as will be obvious, the same supply reel mounting can be used for that purpose.

In one modified form of the invention means may be provided for imparting an initial rotary motion to the reel, thereby to induce immediately the desirable rotational action to avoid the twisting above-described and to avoid the strain on the cable resulting from overcoming the inertia of the reel and its cable when starting its rotation, and to thereby allow the projectile to pull the cable up higher. One suggested means for effecting this operation is shown in Figs. 7 and 8. As there shown the lower portion 601 of the reel tube 600 is spaced slightly from the outer walls of the gun 602. The inner cylindrical surface of the tubular portion 601 is provided with a plurality of vertical corrugations or grooves 603 which form, in effect, turbine blades. The firing chamber 16 of the gun is provided with a plu-

rality of outwardly-disposed ducts 604 which connect with angularly-disposed vents or nozzles 605, the latter being directed so that the explosive gases issuing therefrom will impinge upon the angular faces of the turbine blades 603. As will be clear from this showing and description, the initial effect of firing the propellant charge in the gun is to cause a small portion of the exploding gas to eject through the vents 605 and impart an instantaneous rotational thrust to the reel tube 601 and consequently to the reel plate and cable thereupon. The upper smaller diameter reel tube 600 acts as a substantial gas check above the rotor 601 while a suitable gasket and bearing 606 may be provided in the lower portion thereof where same contacts the shoulder 11 on the gun base.

Obviously other means may be provided for imparting initial rotary motion to the cable reel. For example, a wound-up spring motor may be released by the pulling of the lanyard so that the reel will begin to rotate as the gun is fired; and obviously also the same general operation can be effected by electric motor means or even mechanically as by starting the reel to spin as the lanyard is pulled, as by wrapping a pull rope about the reel and starting same to spin when the rope is pulled in the manner similar to which one cranks an outboard motor.

In operation it will be understood that my gun is designed primarily for defense against low-flying aircraft so that a barrage of steel cables, anchored to the projectile weights at the top and to the reels which slide freely on the gun barrel at the bottom, can be suddenly thrown up in front of low-flying attacking planes. By remote control firing this cable barrage can be erected without necessarily exposing the operator of these guns to danger from the guns or bombs of the attacking planes. The invention is not designed to take the place of aimed anti-aircraft guns where such guns can be effective, but to be used where the time element is so short that aimed guns are ineffective, often as an auxiliary weapon.

The steel cable forms a vertical line traveling upwards or downwards with some speed and strong enough to exert a good pull on a plane running into it, so that the cable tends to saw through the wing, whip its projectile weight into the plane at some point, and by exerting the full tensile and sawing strength of the cable against the plane, tends to wreck it directly or unbalance its flight so that it hits the ground before it can recover; or at least the cable will destroy the aim of the attacking plane.

The shock of the plane hitting the cable would be cushioned by the inertia of the free projectile weight at the top and at the bottom by contact against the yielding reel pins and by the inertia of movement of the reel about the gun. If the pull becomes too great, the reel may slide off the barrel perhaps after overturning the gun itself thus leaving the cable around the plane with substantial end weights on the cable. With the gun barrel securely anchored in its vertical firing position by its own weight or otherwise the cable and reel will snub the bottom end of the cable in a cushioned manner against the gun barrel. If the cable is not hit by a plane, there is no parachute to carry the cable away with wind, warn off attacking planes, etc., or to hold it aloft longer than necessary, and the cable can be speedily rewound around the outside of the reel and thus cleaned up out of the way very quickly.

Smoke trails and whistles can be used in the projectiles to minimize danger to those below. The projectile usually falls some distance away from the base of the gun according to the wind and any deviation from vertical of the barrel when the gun is fired, whether accidental or intended.

I have found that the great speed of rotation of the reel engendered by the firing is sufficient to wind up a large length of the cable around the outer row of pins as the cable comes down. This rotation can then be continued by hand, or by mechanical means to wind up all the cable quickly, to get it out of the way, to save it for reuse, and so that the fired reel may be readily taken off and a new reel put on to rapidly prepare the gun for refiring.

As the gun is fired by a lanyard, or electrically, it can be fired by remote control at any distance from its base. An electric eye, or small "radar" type of detector, which sighted to a certain height, say 300 feet, in an inverted cone area from the base of the gun, may be caused to operate a relay and fire the gun automatically when any sizeable object flew into the large circle of detection above the gun. This type of control would be useful on fixed installations such as bridges, roofs of power plants, railroad areas, etc., where friendly planes could be kept away.

The present invention would have been most effective if it had been installed to defend an airport like Hickam Field, Hawaii, from a sudden attack on grounded planes, barracks, etc., as occurred on December 7, 1941, where the attackers were reported to have machine gunned and bombed the field at heights of fifty feet and less, doing their damage before our fighter planes could get off the ground and killing our gun crews before they could get to their guns. In such an installation a control tower or observation post strategically located so as to command a view of the whole field and containing switchboards to set off one or more cable-throwing guns at any strategic point, would be constantly maintained. On sighting enemy planes coming in for a low level attack the operator would close the switches which would fire cables into the path of the oncoming planes. If these cable throwing guns were set up at the ends of runways, or in the runways on the landing field, they would have flap covers which would open when the gun was fired but the rest of the time would allow planes to roll safely over them.

Other tactical employments of the invention are suggested, as follows: Troops or transports of any kind, in line formation, can have guns arranged so as to throw up a line of cables in the line attacking low level planes would naturally follow. Military trucks can have guns mounted on their cab roofs. Tanks could carry at least one apiece, which could be fired and the reel rewound to pick up the used cable or be discarded from inside the tank. Trains might have one on every other box car roof, to be fired by the observer in the engine or caboose. Lines of men landing to take a beach head where they are likely to be strafed might have these guns on landing barges, set up along the line of their formations or supplies. Ammunition dumps, communications headquarters and all strategic targets should have these guns set up to be fired by whoever first saw attacking low-flying planes. All gun emplacements would have these guns so that the crew could dive for cover and fire the cables into the air, rather than be wiped out by the eight or more

machine guns of a low flying plane. Knowledge that these cable-throwing guns were in general use might effectively deter many low level plane attacks, or force the attackers to fly at levels high enough to make regular AA guns effective. Their installation would not reveal the location of loci to be protected, as is the case with balloon barrage installations, for example.

On ships, the guns should be placed preferably in the stern, so that the falling projectiles and cables would trail behind the propellers and not foul them when being reeled in. Fired from the bridge they would allow the operators to stay sheltered. If the guns were mounted at an outward angle along the sides of a ship they could be arranged so that the reel would be thrown clear of the ship also if there was danger of fouling propellers when fired from forward positions.

With the barrel tilted at angles below the vertical the gun works well as a "line-throwing" gun, with the advantage that the metal cable is far stronger and not so likely to snap or burn off as is the light rope used by the Coast Guard life-saving line-throwing gun. As the cable my gun throws is strong in itself, it can be used by engineers to throw a line across a stream where it will tangle itself in tree branches, or where it can be fastened on the other side by one man, without the necessity of his pulling a line across the current with him, and thus make possible the holding of boats and men against a swift current when making a speedy crossing. The steel cable thrown up a mountain can be made fast at the top and thereafter used to haul guns or other supplies up the steep grade. It can be used to throw a strong cable across any ravine, or to any point where it would be costly in time or effort to get a similar line across by usual means. As the line will not burn, it can be thrown over burning water, oil, brush, to help men stranded on the other side, such as a burning tanker with oil burning on the water around it, at sea.

This gun could be used by ground troops to throw its projectile and cable over suspected land mine fields, mine traps, or barbed wire, so that by pulling back on the cable hidden mines could be exploded and barbed wire pulled away without danger to the troops.

Among other novel features the invention differs from other line-throwing devices, whether gun or rocket, in its ability to make high strength steel cable hold on to a projectile without breaking or losing tensile strength, and in the means for handling the steel cable so that it will pay off readily, be practical to use and reuse, and stay fastened top and bottom in a cushioned manner when struck by a plane.

The invention in its broader aspects is not limited to the specific mechanisms shown and described but departures may be made therefrom within the scope of the accompanying claims without departing from the principles of the invention and without sacrificing its chief advantages.

What I claim is:

1. A weapon for projecting a cable into the air including in combination a gun, a projectile to be fired from the gun, a reel mounted on the gun and rotatable relative thereto, and a coil of cable supported on said reel, the free end of the cable being attached to the projectile so as to be drawn therewith in its flight, and motor means apart from the cable for imparting an initial rotation to said reel.

2. A weapon for projecting a cable into the air

including in combination a gun, a reel mounted on the gun coaxially with the barrel thereof, a projectile to be fired from the gun, and a supply of cable carried by said reel, said cable being arranged on the reel in a plurality of spaced concentric cylindrical layers and wound in coils running from the top to the bottom of each layer, the free end of the cable from the top of the layer adjacent to the gun barrel being attached to the projectile to be drawn thereby in its flight as the coils of cable pay out through the space between the adjacent layers of the windings.

3. A weapon for projecting a cable into the air including in combination a gun, a projectile to be fired from the gun, and a length of cable having a free portion thereof attached to the projectile and arranged to be drawn by the projectile in its flight, the trailing portion of said cable being coiled on a rotatable support comprising a platform having vertically disposed pins secured therein at their lower ends in a plurality of radial rows, the cable being coiled over successive annularly related pins from the inner to the outer edge of the platform, and the inner annular series of pins being spaced from a vertical central core member a sufficient distance to enable bending of said pins and subsequent series thereof toward said core as the cable is uncoiled under the pull of the fired projectile, whereby to form a conical surface for free passage thereover of the initially uncoiled windings of the cable.

4. In apparatus for ballistically projecting a cable into the air by firing a projectile to which its leading end is attached, in combination, a base, a length of metal wire cable formed in a plurality of concentric cylindrical layers coiled on said base, and spacing means between each layer and its adjacent layers for separating said layers a distance sufficient for free passage of the coils of the cable withdrawn from the successive layers by the pull of the projectile.

5. In apparatus for ballistically projecting a cable into the air by firing a projectile to which its leading end is attached, in combination, a base, a plurality of upright relatively concentric layers of wire cable mounted on said base and adapted to pay out therefrom under the tug of the projectile when fired, said cable being wound to pay out from the inner to the outer layer and from the top to the bottom of the successive layers.

6. In apparatus for ballistically projecting a cable into the air by firing a projectile to which its leading end is attached, in combination, a base, a plurality of spaced upright concentric layers of a length of wire cable mounted on said base and wound to pay out from the top toward the bottom of each layer under the tug of the projectile when fired, and spacing means over which said cable is wound to form said layers, said spacing means being fixed to the base and being sufficiently flexible toward the axial center of the layers to yield toward said center to reduce resistance to paying out of the coils of cable under the contracting influence thereon of the fired projectile.

7. In apparatus for ballistically projecting a cable into the air by firing a projectile to which its leading end is attached, in combination, a base, a length of metal wire cable coiled on said base in a plurality of upright concentric layers, and a plurality of annularly arranged rows of upright pins over which the cable is wound to form said layers, said rows of pins being spaced

apart to provide clearance between the layers for release of the cable upon firing of the projectile and said pins being secured to said base but yieldable whereby to maintain the coils wound thereover in tension and to flex toward the axial center of the layers upon contraction thereabout of the coils withdrawn under the tug of the fired projectile.

8. In apparatus for ballistically projecting a cable into the air by firing a projectile to which its leading end is attached, in combination, a base, a length of metal wire cable coiled on said base, at least a portion of said cable toward the end thereof attached to the projectile being axially twisted on itself in a direction opposite to the twist introduced in uncoiling of the cable under the pull of the projectile when fired.

9. In apparatus for ballistically projecting a cable into the air by firing a projectile to which its leading end is attached, in combination, a base, a plurality of spaced layers of wire cable disposed in upright concentric relation on said base and being adapted to pay out therefrom from the top toward the bottom of the successive layers, said cable being wound so as to pay out from the inner to the outer layer and in contiguous coils running from the top to the bottom of each layer and at least a portion of said cable in the inner layers being axially twisted on itself in a direction opposite to the twist introduced upon uncoiling of the cable under the pull of the projectile.

10. In apparatus for ballistically projecting a cable into the air by firing a projectile to which its leading end is attached, in combination, a base, a length of metal wire cable formed in a plurality of upright relatively concentric layers coiled on said base and spacing means between each layer and its adjacent layers separating the layers a substantial distance from each other to provide clearance for release of the coils of the cable from the successive layers under the pull of the projectile, said spacing means comprising upstanding members fixed to the base and bendable toward the axial center of said layers under the unwinding torque of the cable when the projectile is fired whereby to reduce resistance to the paying out of the cable.

11. In apparatus for ballistically projecting a cable into the air by firing a projectile to which its leading end is attached, in combination, a rotatable base, a length of metal wire cable formed in a plurality of upright relatively concentric layers coiled on said base and spacing means between each layer and its adjacent layers providing clearance for the coils of the cable in the successive layers to feed out freely under the pull of the fired projectile, said spacing means comprising upstanding members rigidly fixed to the base but flexible and adapted to yield inwardly as the coils of the cable are constricted under the pull of the projectile to reduce resistance to rotation of said base induced by said constriction and the unwinding torque of the cable.

12. In apparatus for ballistically projecting a cable into the air by firing a projectile to which its leading end is attached, in combination, a base, a continuous length of metal wire cable formed in a plurality of upright concentrically disposed layers coiled on said base from the top to the bottom of each layer, and spacing means over which the cable is wound to form said layers at spaced intervals greater than the size of the cable, said spacing means providing surfaces for the guidance and free sliding thereover of the

cable uncoiled by the tug of the projectile and providing a barrier against contact of the coils paying out from one layer with the static coils of an adjacent layer.

13. In apparatus for ballistically projecting a cable into the air by firing a projectile to which its leading end is attached, in combination, a base, a plurality of spaced concentric layers of wire cable mounted on said base and adapted to pay out therefrom under the tug of the projectile when fired, and means over which the cable is wound to form said layers with the coils thereof running from the top to the bottom of each layer and with the layers spaced a substantial distance apart whereby to pay out from the top toward the bottom of the successive layers through the separation provided between the layers.

14. The combination as set forth in claim 13 wherein the cable from the bottom coil of each layer extends to the top coil of the next layer in a slack stretch through the space separation between the layers and is tied to the spacing means at the top and bottom ends of said slack stretch by a fragile tie-piece easily breakable under the tug of the projectile.

15. A weapon for projecting a cable into the air including in combination a gun, a projectile to be fired from the gun, and a length of cable having a free portion thereof attached to the projectile and arranged to be drawn by the projectile in its flight, the trailing portion of said cable being coiled concentric with the gun on a support mounted on the latter for rotation induced upon uncoiling of the cable under the pull of the fired projectile, said rotatable support comprising a platform having vertically disposed pins secured therein at their lower ends and spaced apart in a plurality of radial rows, and wherein the cable is wound over annularly related pins in contiguous coils forming concentric cylindrical layers of increasing diameter from the inner to the outer edge of the platform, said pins being adapted to yield toward the axis of rotation of the platform under the uncoiling action of the cable when pulled by the projectile in flight.

16. In apparatus for ballistically projecting a cable into the air by firing a projectile to which its leading end is attached, in combination, a base, a plurality of spaced upright concentric lay-

ers of a length of wire cable mounted on said base and wound to pay out from the top toward the bottom of the successive layers under the tug of the projectile when fired, and spacing means over which said cable is wound to form said layers, said spacing means being fixed to the base and being sufficiently flexible toward the axial center of the layers to yield toward said center to reduce resistance to paying out of the coils of cable under the contracting influence thereon of the fired projectile, the axis of said layers and spacing means extending substantially parallel to the line of departure of the fired projectile.

17. In apparatus for ballistically projecting a cable into the air by firing a projectile to which its leading end is attached, in combination, a length of metal wire cable wound in a plurality of coils, said cable being axially twisted on itself in the successively wound coils thereof in a direction opposite to the twist caused by lineal extension of the static coils in a direction substantially axially thereof under pull of the projectile.

18. In apparatus for ballistically projecting a cable into the air by firing a projectile to which its leading end is attached, in combination, a length of metal wire cable wound in a plurality of coils, said cable being axially twisted on itself in the successive windings thereof in a direction opposite to the twist introduced upon uncoiling of the cable under pull of the projectile, the amount of such axial twist being approximately 360° for each 360° turn of the cable within said coils.

19. In apparatus for projecting a cable into a lineal stretch from a coiled hollow-core mass thereof, in combination, a length of metal wire cable wound in a plurality of coils, said cable being axially twisted on itself in the successively wound coils in a direction opposite to the twist caused by lineal extension of the static coils in a direction substantially axially thereof, the inner end of said cable extending from the central portion of said coils and said coils being unobstructed at the end thereof from which they are to be unwound whereby said cable may be unwound beginning at the innermost coil and through said unobstructed end.

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