Aug. 2, 1966 L. G. SMITH, JR 3,264,417

WIRE RELEASE MECHANISM

Filed April 16, 1962 3 Sheets-Sheet 1

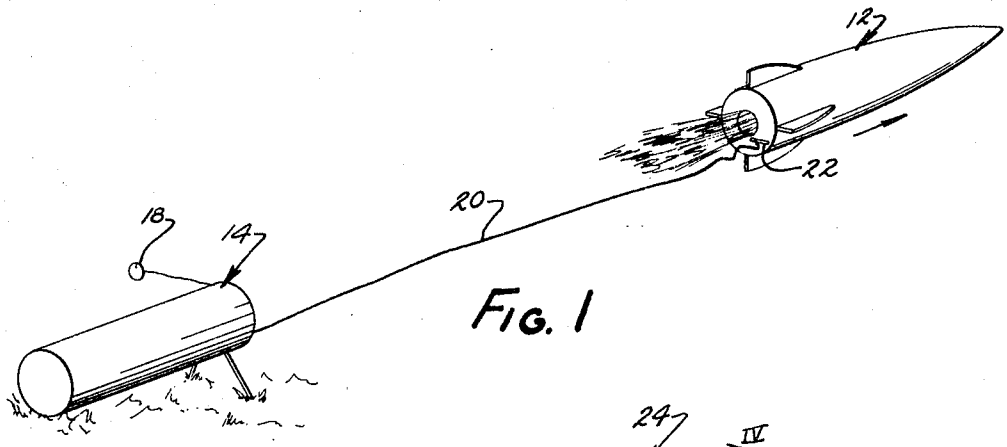


FIG. 1

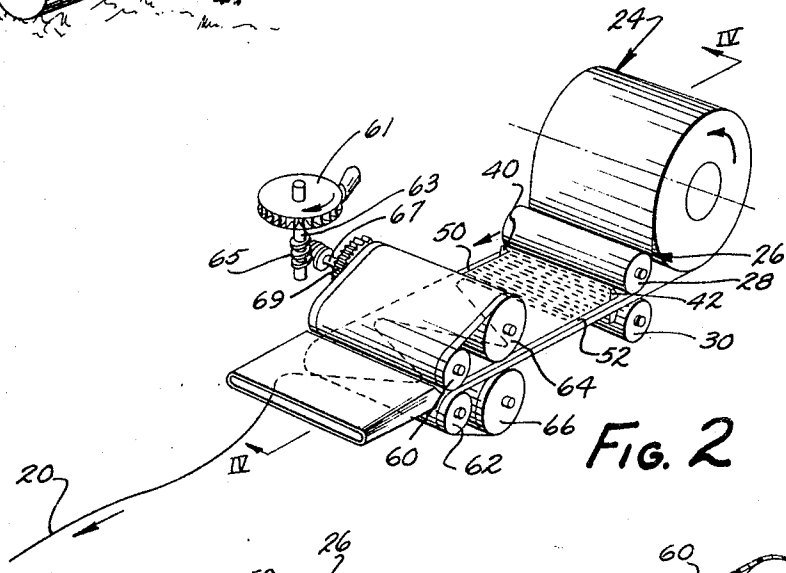


FIG. 2

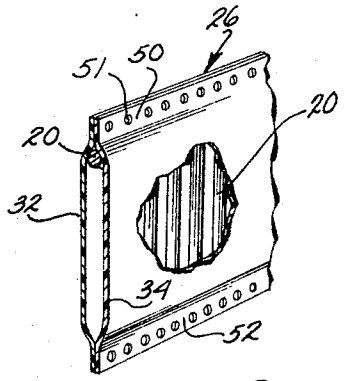


FIG. 3

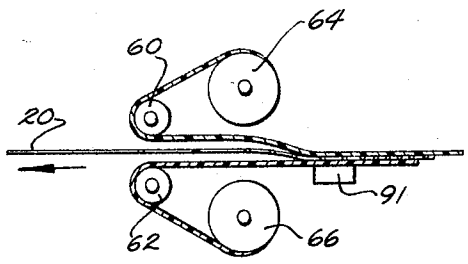


FIG. 7

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WIRE RELEASE MECHANISM

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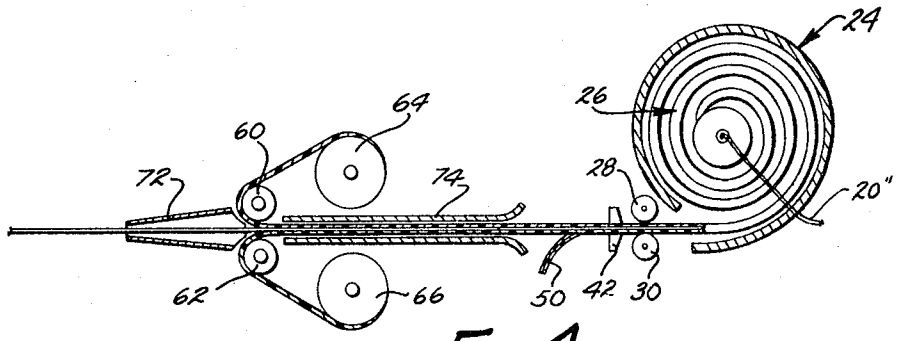


FIG. 4

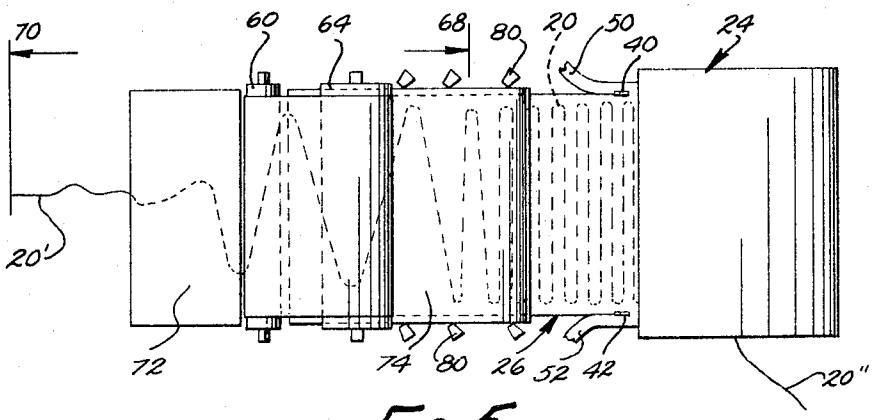


FIG. 5

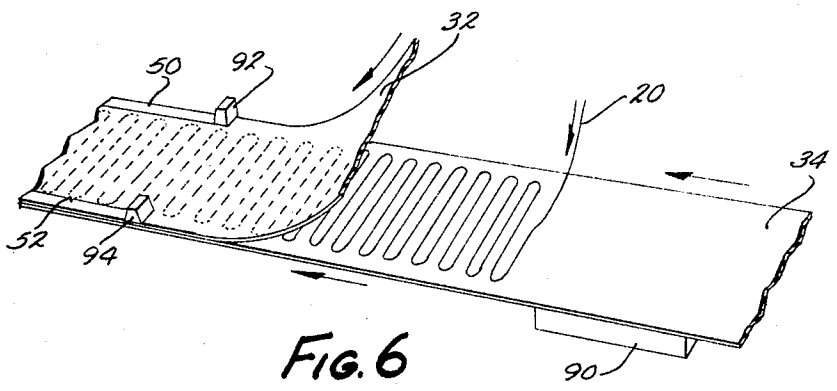


FIG. 6

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WIRE RELEASE MECHANISM

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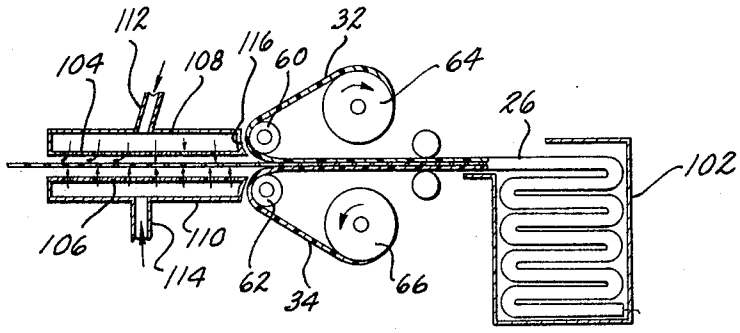


FIG. 8

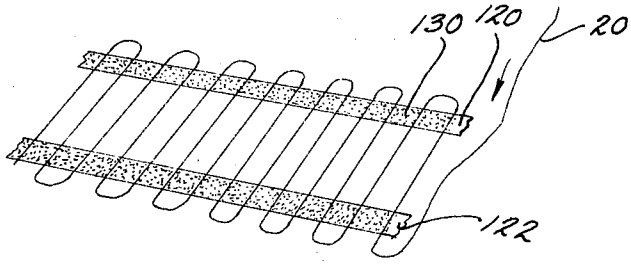


FIG. 9

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United States Patent Office 3,264,417 Patented August 2, 1966

3,264,417

WIRE RELEASE MECHANISM

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Filed Apr. 16, 1962, Ser. No. 187,759
1 Claim. (Cl. 191—12)

This invention relates to equipment for handling a continuous strand-type element, especially a signal conducting means, and more particularly to a releasing mechanism and method for a signal conducting means. It also relates to a novel storage and release mechanism for a strand-type element, especially a signal conducting means.

With the development of self-propelled projectiles for line-of-sight warfare operations to destroy objects such as tanks and trucks, it has been found advantageous to provide constant control during their movement by using signals which cannot easily be interferred with or detected. One of the methods currently employed utilizes the transmission of electrical signals by wire. To effect this signal transmission, the wire must constantly extend between the moving object and the signal source.

However, conventional wire releasing mechanisms, such as the coil or bobbin type, are not capable of releasing successive portions of the wire rapidly enough for many high-speed objects or vehicles. With these mechanisms, the wire adjacent to the storage and releasing means is caused to accelerate in an extremely small distance. This rapid acceleration causes excessive tensile forces in the conductors, resulting in separation or breaking of the conductor at the release point.

Consequently, there exists a definite need for a release mechanism capable of dispensing the signal conducting means sufficiently rapidly for high-speed vehicles such as projectiles, missiles or aircraft, and capable of permitting the required acceleration without excessive stresses in the signal conducting means.

Another serious disadvantage with conventional coil or bobbin releasers, when electrical conductors are used for transmitting electrical signals, is the very high self-inductance of the coil or bobbin, often reaching four henries in value. Further, this self-inductance varies with the amount of wire remaining in the coil, making effective electrical signal transmission difficult. This problem is especially acute since control of missile flight, for example, requires reliable transmission of highly refined signals of controlled band width and low noise level, among other things. Therefore, even when the conductor does not break during release and acceleration from the coil, for example when it is used on lower velocity vehicles, the electrical signal transmitted must overcome this very high and rapidly varying inductance in order to be at all effective.

It is an object of this invention to provide novel equipment for storing and dispensing strand-type material, especially signal conducting means. It is also an object to provide a releasing device for releasing a signal conducting means at greatly increased rates as compared to those known heretofore. Another object is to provide a device which distributes acceleration forces over a relatively long segment of the releasing signal conducting means, i.e., over a relatively long acceleration zone, rather than over a relatively short increment. It substantially extends the time of acceleration of each segment as it is released, to thus largely reduce the tensile forces developed in the signal conducting means or strand.

It is another object of this invention to provide a novel storage and releasing device capable of relasing the signal conducting means rapidly enough to accommodate even very high velocity objects such as projectiles, missiles, and aircraft.

It is a further object of this invention to provide a storage and releasing article and device capable of compactly storing at least several thousand feet of electrical conductors and releasing the same at rapid rates without having a large inductive impedance in the signal transmission means.

It is a still further object to provide an apparatus capable of electrical signal communication through a strand-type material such as a wire or wires, even though it extends between a stationary position and an object moving at high rates of speed, or between two simultaneously moving objects.

Another object is to provide a novel method of storing and releasing strand-type material, especially signal conducting means, rapidly, without excessive tensile forces in the acceleration zone, and without substantial friction drag.

These and other objects of this invention will be apparent upon studying the following specification in conjunction with the drawings in which:

FIG. 1 is a perspective view showing a moving object such as a missile which contains the storage and release mechanism for a signal conducting means;

FIG. 2 is a perspective view of a storage and releasing device for a signal conducting means;

FIG. 3 is a fragmentary, perspective, exaggerated view of a storage article or packet before release of a strand or signal conducting means;

FIG. 4 is a side elevational, sectional view of the storage and releasing mechanism taken on plane IV—IV of FIG. 2;

FIG. 5 is a top plan view of the storage and releasing device illustrated in FIG. 4;

FIG. 6 is a perspective view showing one method of assembly of one form of the novel signal conducting means storage article or packet;

FIG. 7 is a fragmentary side elevational view of a first modification of a release mechanism;

FIG. 8 is a side elevational, sectional view of a second modification of a storage release mechanism; and

FIG. 9 is a fragmentary perspective view of a modified strand storage or packet.

Non-limiting examples of signal conducting means employed in this invention are an electrical conductor or a plurality of electrical conductors, a cord, string, rope or cable; a tubularly-shaped member; or optically conducting glass fiber or fibers; etc. The electrical conductor can consist of any electrically conducting material well-known in the art as for example metallic wire such as copper, nickel, silver, gold and steel wires, as well as wire alloys of these and other materials. The conductors can be insulated, which is the case where two or more strands are used. Another example, is an electrical conductor or conductors in the form of thin metallic filaments or films supported by a tensile member such as a cord or mono-filament of a synthetic or natural material. Non-limiting example of support members are cords and mono-filaments of nylon, cotton, glass fibers, silk, etc.

In the written description given hereinafter, the invention is illustrated by reference to a wire as the signal conducting means. It is to be understood that the same is for the purpose of illustration only and is not to be taken as a limitation, since any strand-type material or signal conducting means can be used in the light of the above discussion.

Basically, the novel wire storage and release article, as shown in FIGS. 3 and 6, includes a packet in the form of a tape. The tape is formed of the strand or strands arranged in a recurring sinuous pattern (i.e., resembling a series of adjacent folds) and a supporting member or members sometimes referred to as a retaining wall or walls. If more than one retaining or support member is

used, the members can be disposed on the same or opposite sides of the wire. A specific example in which a wire is sandwiched between two retaining members or ribbons is illustrated in FIG. 3 of the drawings. Each of such ribbons can be replaced, however, with one or more ribbon strips, i.e., strips that are narrower than the fold length of the wire on opposite sides. Alternatively, the signal conducting means can be disposed on one or more strips, located on one side of the signal conducting means as in FIG. 9 of the drawings. A signal conducting means can also be disposed on but a single retaining member. This storage and release article can be rolled as shown in FIGS. 2, 4 and 5 of the drawings, or folded or otherwise disposed in a manner compatible with the storage space available as shown for example in FIG. 8 of the drawings.

In the case where the retaining member or members is disposed only on one side of the folded wire, an adhesive can be made use of to retain the wire in position on the supporting member or members until release of the wire is desired as hereinafter explained. Normally, an adhesive is not required. The retaining walls in the figures in the drawings are flexible, ribbon-type elements. One manner, but not limited thereto, is to retain the sinuous wire in position by joining the edges of two oppositely disposed ribbons with the wire sandwiched in between.

The novel storage tape is used in conjunction with a releasing device having a storage chamber such as a reel or other means as explained above whereby the tape is compactly stored, allowing dependable removal of the ribbon therefrom. The device includes ribbon removal or stripping means for allowing substantially frictionless unfolding and acceleration of the wire. Removal of the sheath walls may be facilitated with edge separating means if edges of the ribbons are sealed, as in FIG. 3. If heavy strand-material is used, it may sometimes be expedient to impart sprocket teeth receiving orifices in the edges of the tape for positive driving thereof.

A guide or acceleration channel is preferably provided for the unfolding wire. Preacceleration means may be associated with the guide and channel for preliminary acceleration to accommodate exceptionally high velocity vehicles. This preacceleration means can for example, comprise a series of properly oriented air jets arranged along the channel, along the lateral edges, and/or on the top and bottom of the channel.

The invention also comprises equipment capable of allowing electrical signal communication between a stationary element such as the starting source, and a movable object, or vice versa, or between two moving objects, as for example, a moving truck and a missile. One or both objects have associated therewith the wire releasing device including the ribbon storage article including a tape formed by wire or strand positioned in a series of adjacent folds and arranged in a sinuous pattern on a ribbon wall or walls. The wire is attached at one end to one object element, often stationary, and at its opposite end to a moving object. A ribbon removal means to allow rapid release of the wire includes edge releasing means if the edges of the ribbon are joined. Other features may also be combined where necessary as explained hereinafter.

The novel method of releasing and extending the wire comprises the steps of arranging a wire in a sinuous pattern resembling folds, confining the folds to a single ribbon or between a plurality of ribbons or walls, permitting relative movement between the portion of the wire being released and the walls, while simultaneously and continuously stripping or removing the walls from the wire. If desired, the folds may be adhered lightly to a wall, and later released from the wall just prior to wire extension and wall removal. Examples of adherent wall or ribbon material that can be used, are paraffin, solidified oils, waxes, etc. disposed on suitable ribbon material such as cloth made of natural or synthetic material such as cotton, silk, nylon, Mylar, Teflon, etc., and metallic ribbons, or plastic sheets such as polyethylene. These are representative rather than limiting examples. These ribbon materials are usually used without the application of an adherent substance as in the illustrations in the drawings. Teflon, Mylar or similar materials can be used when a material of extremely low friction is desired.

The term "sinuous" is intended according to its definition as provided by Webster's dictionary, i.e., "of a serpentine or wavy form," and is not to be limited to the term "sinusoidal."

Referring to the drawings, in FIG. 1 the novel device is shown in combination with one form of moving object, namely a missile, or projectile **12** propelled from a stationary source element **14** toward a target (not shown). In order to provide electrical communication between a signal transmitter **18** and a receiver (not shown) in the missile **12**, or vice versa, a wire **20** is constantly released to extend between the stationary element and the moving object **12**. The wire releasing and storage mechanism may be mounted within the object as illustrated in FIG. 1, or externally to the object depending on the nature and size of the object involved, the movement and surface characteristics of the object and its intended purpose. Also the releasing mechanism may be mounted to the source. Further, a pair of mechanisms may be mounted respectively to the source and object. The electrical signal may be used for many purposes. For example, the flight path of the missile illustrated in FIG. 1 can be controlled through the transmission of sophisticated, high quality signals.

The wire **20** is stored and released in the moving object within a novel wire storage and release article comprising a wire packet or tape **26** as illustrated by FIG. 3 (see FIGS. 5 and 6 for sinuous arrangement). This tape comprises an enclosing sheath having a pair of opposite, flexible ribbon-like walls **32** and **34** which are joined along their overlapping edges to enclose wire **20** compactly arranged in a series of adjacent folds as shown in FIGS. 5 and 6. Other tape constructions have been discussed above and are shown. It will be obvious that the particular enclosing structure forming the walls may vary. For example, a single folded ribbon, a seamless extruded sheath, a single adhered ribbon, a plurality of narrow strips, or other equivalent structures could perform generally the same function.

This tape illustrated could be formed by arranging the wire in its sinuous pattern on a lower ribbon, then placing an upper ribbon on the wire, and then securing overlapping edges of the ribbons together. Alternatively, the wire could be stuffed between a pair of walls. The forming process could be adapted to continuous operation, as is obvious.

The wire **20** is released through a suitable outlet **22** on the moving object. One form of the novel device for rapidly releasing the stored wire is shown in FIG. 2. It includes a ribbon storage and discharging means **24** such as a magazine or spiral reel. The tape or wire packet **26** is discharged from this reel in a guided fashion, as for example between a pair of rollers **28** and **30**.

To provide optimum release and unfolding conditions for the wire **20**, increcents of the walls **32** and **34** are constantly removed as the wire is accelerated to its extended condition. When the edges are joined or sealed, this may be done by releasing the sealed edges **50** and **52** of the sheath. In the form shown, the sealed edges of the sheath are cut off by a pair of cutting elements **40** and **42**. Edge releasing methods for different materials used for the walls will vary. For some purposes, the edges may merely be crimped together so as to be releasable by pulling them apart. At other times, as with the sealed edges shown, it may be necessary to sever the edges. The respective walls are then passed around idler rollers **60** and **62**, and wound up on secondary rollers **64** and **66**. Sprocket means may be utilized to drive the edges of the

tape using openings **51** for positive drive means. The plastic edges may be strengthened by metallic coatings or strips of metal or other material to reduce stretching or tendency to tear when driving.

The wire becomes extended as it passes through the acceleration zone beginning where the wire starts unfolding (**68**) and ending where the wire is linear (**70**) and generally coaxial with the centerline of the folds. In certain instances it is desirable to provide a channel **72** beyond the rollers **60** and **62** and/or an acceleration guide channel **74** prior to removal of the walls or panels.

If desired, preacceleration means such as a series of air nozzles **80** along the edge, on top, or on the bottom may be used to start and/or continue the unfolding action of the wire adjacent to and through the zone of acceleration. Thus, the length of the zone of acceleration can be increased, and stresses on any increment of wire can be even further reduced. Similar air directing means can be used to retard rate of wire acceleration or to variably control acceleration rates. Even smoother releasing occurs where practically all friction of wire-on-wall is eliminated during extension. In the apparatus illustrated in FIG. 8 for example, as the tape **26** is unfolded from storage chamber **102**, and the walls **32** and **34** pass around idlers **60** and **62** and are wound up around rollers **64** and **66**, wire **20** passes between perforated plates or walls **104** and **106** forming inner surfaces of a pair of gas manifolds **108** and **110**. The flowing gases introduced through inlets **112** and **114** pass out the perforations and maintain the wire **20** suspended in a gaseous cushion, and in an accelerated state due to the outflowing gases. One means of accomplishing this is by passing air or other gas such as helium, for example, through porous wall material such as porous metal or ceramic, e.g., sintered, porous steel or brass, or through ports or orifices in the walls. Directional control of the gaseous flow may be achieved by the positioning and configuration of the inner end **116** of the manifold or by the alignment of the ports or orifices so as to cause directed flow of the escaping gas.

Generally, the wire is adequately retained without adhering it to the walls. The wire may, however, be formed in a manner to provide a slight adhering effect between the wire and one or both of its confining walls to even further secure it in an exact position. This is especially true of course where only one side of the wire is contacted by wall means. When this is done, the adhesive effect should be readily releasable just prior to the acceleration zone. One way of achieving this is shown in FIGS. 6 and 7. In FIG. 6, at least wall **34** is a ribbon of a suitable thermoplastic material. Possible materials include a vinyl (such as vinyl acetate, vinyl chloride, etc.) cellulose acetate, polyethylene, and many others. It underlies and supports the wire **20** which is placed thereon in a sinuous pattern. By passing the thermoplastic lower sheet **34** over a heated platen **90** the thermoplastic material may be softened to provide a slight tackiness so that wire **20** will remain securely in position. Thereafter, top sheet **32** is placed on the wire and the edges **50** and **52** of the sheets are bonded together as by a pair of heated edge platens **92** and **94**. As explained above, the top sheet can be omitted. For example, wall strips such as strips **120** and **122** (FIG. 9) may be placed on just one side of the wire. The packet is then placed in a suitable storage means such as reel **24** for dispensing as in FIG. 2.

As the ribbon or packet is dispensed, the wire is released from its adhered condition prior to removal of the walls. This may be accomplished by placing a heat source **91** (FIG. 7) to react on wall or sheet **34** just prior to the acceleration zone of the wire. This reheats the thermoplastic material sufficiently to largely destroy the adhering condition, and allows free movement of the wire relative to the retaining wall or walls. Other equivalent methods may be utilized for this adhering effect, such as the addition of a slight amount of adhesive. For example, an adhesive **130** shown on strips **120** and **122** in FIG. 9 is chosen so that it changes to volatilize or liquefy by heat to thereby release the wire when desired. Examples of adhesives are acrylic (e.g., methyl methacrylate, methyl methacrylate-styrene copolymer), polyvinyl butyral and other polyvinyl acetals, among others. Instead of an adhesive, a corresponding pair of strips (not shown) may be placed opposite strips **120** and **122** to retain the strand **20**.

Operation

The method of operation of this invention is as follows. Briefly, it comprises arranging or forming the wire into a sinuous pattern so as to form a plurality of adjacent recurring folds. This sinuously disposed wire is concurrently or after the forming step, packaged into a tape which retains this disposition during the storage thereof. The wire is released and extended by substantially simultaneously releasing the retaining means and permitting relative movement between the released portion of the wire and the tape. This method can be utilized in many ways and forms.

When it is desired to release wire from the storage means, as for example to provide a signal conducting means between a moving object such as the missile illustrated in FIG. 1 and a stationary element, the storage and releasing device illustrated in FIGS. 2 and 4 is mounted to the moving vehicle. One end of the signal conducting means is connected to the source electrically and physically, if it comprises an electrical conductor. It is attached at both ends, the other end of the signal conducting means **20″** (FIG. 4) being connected to the moving object. When the object moves away from the source, the wire packet or tape in the form shown wound on the reel or other storage means **24**, is fed between a pair of guiding rolls **28** and **30**, past edge releasing means **40** and **42**, and preferably through an acceleration channel **74** and/or **72**. As the wire and enclosing walls approach the area where the enclosing walls are removed, the wire begins and continues unfolding over the length of the acceleration zone. The ribbon is drawn by winding-roller **64** due to driving rotation of its shaft **67**. This shaft can be driven by a worm gear engagement **65** on shaft **63** driven by a turbine **61** or other torque generating device such as a motor and pinion drive. Alternatively, the take-up rolls **64** and **66** can be rotating elements of a motor or engine or other torque generating device. The turbine may be rotated by hot gases from the missile, for example. A spur gear **69** on roller **64** can be used to drive a similar spur gear (not shown) on roller **66** to wind up both walls of the sheath.

Due to the sinuous pattern of the wire, tensile forces are imparted during wire releasing and acceleration to substantially large segments of the wire, i.e., that portion in the acceleration zone between **68** and **70**. Also, the time of acceleration for the wire moving through this zone is substantially large so that no small increment of wire is stressed excessively. When the wire becomes linear at **20′** (FIG. 5), it becomes stationary, having substantially no velocity and no acceleration relative to its general environment when the apparatus is suspended to the moving vehicle. It will be realized that the rate of ribbon movement from storage reel **24** may be controlled in proportion to the vehicle speed to discharge the proper amount of wire or other signal conducting means.

As stated hereinabove, in instances where extra high velocity objects are involved, or extra fine wire is used and no significant stresses at all should be imparted to the wire, it may be desirable to provide preacceleration means associated with the guide or acceleration channel. This further extends the zone of acceleration, and further lengthens the increment of wire simultaneously being accelerated. Properly positioned air nozzles **80** connected to a suitable air source (not shown) will cause the wire to unfold more quickly to extend the time of acceleration. Also, it may be desirable under certain circumstances to actually increase the tension of the wire by pressure ap-

plied to the ribbon using pneumatic or mechanical means.

It is important to note that with the sinuous wire pattern utilized in this invention, electrical signals sent through a wire encounter minimal inductive impedance, as compared to high and varying inductance encountered in conventional coil or bobbin releasers. Therefore, self-inductances of previous coil and bobbin releasers which interefered with signals and prevented accurate control with high quality signals, are eliminated.

Although the apparatus has been explained with respect to a particular type of moving object, the device can be used in combination with various types of moving objects, or for many other different uses than providing communication between a moving object and a stationary element, or between two moving objects to eliminate the need for dragging the wire through its environment, whether it be gaseous, liquid or solid. This could be very advantageous and even critical, for example, for two trucks desiring communication while moving through brush or trees. It can also be used many various ways to dispense wire for high speed assembly processes, such as in the electrical industry. To rapidly dispense motor or transformer-winding wire in a rapid continuous manner is one example. To rapidly and safely dispense fibers of materials such as plastic, glass, or the like to wrap items or supply a coating of fibers is another use. Many other possible uses will occur to those in the art.

In a specific, illustrative use, when a mechanism of the type shown in FIG. 2 contains a bi-filar strand of No. 35AWG resin insulated copper wire is used in dispensing wire from a moving vehicle traveling at a velocity of substantially 800 to 1000 ft./sec. over a distance of 6000 meters, it is found that the wire is dispensed satisfactorily. No impairment of the signal transmission capability occurs in the wire that is thus dispensed. The transmission characteristics of the wire so dispensed are sufficient to permit transmission of high quality signals allowing accurate control of a vehicle.

Various modifications may be made of the article, device, and method taught within the principles of the invention to suit a particular situation due to its many potentialities. Therefore, the invention is not to be limited merely to the illustrative forms shown, but only by the scope of the appended claim and the reasonably equivalent structures thereto.

I claim:

A storage and releasing device for a signal conducting means comprising: a signal conducting means positioned in a sinuous pattern; ribbon wall supporting means releasably sustaining said signal conducting means; ribbon wall removal means engaging and retracting said ribbon means away from said signal conducting means to allow release and extension of said signal conducting means; and gas cushion injection means adjacent said removal means oriented toward opposite sides of said signal conducting means to suspend said signal conducting means and cause extension in an essentially frictionless manner.

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