United States Patent

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[15] **3,677,309**

[45] **July 18, 1972**

[54] WIRE FORMING APPARATUS

[72] Inventor: **Andrew J. Grandy**, 2707 Grant Avenue, North Hills, Pa. 19038

[22] Filed: **June 24, 1970**

[21] Appl. No.: **49,484**

Related U.S. Application Data

[62] **Division of Ser. No. 823,232, March 28, 1969, Pat. No. 3,566,504, which is a division of Ser. No. 180,058, March 15, 1962, Pat. No. 3,470,861.**

[52] **U.S. Cl.** **140/149**, 72/128

[51] **Int. Cl.** **B21f 7/00**

[58] **Field of Search** 140/89, 149; 29/173, 452; 72/127, 128, 77, 78, 371, 137; 148/12.4; 89/36; 124/18

[56] **References Cited**

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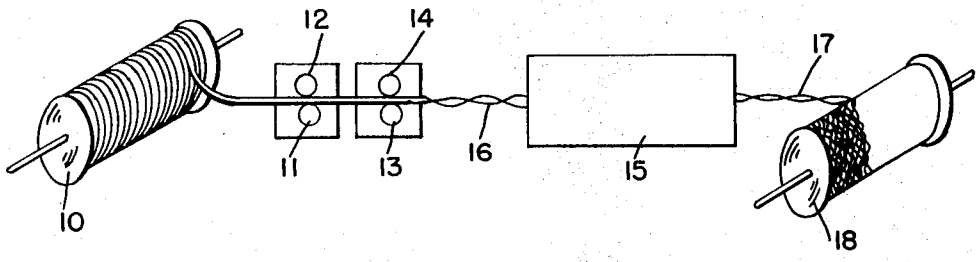
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[57] **ABSTRACT**

Apparatus for forming a wire for use in a wire gun in which pairs of rollers are provided to twist the wire in its soft condition beyond its elastic limit prior to heat treating and stress relieving the wire. Additional pairs of rollers are provided to reverse the twist in the wire below the elastic limit of the wire to a flat wire condition for winding into a coil upon a reel having a locking slot. The wire thus formed is subjected to but a single stress below the elastic limit of the wire and the tendency of the wire to fracture is eliminated. The wire has the capacity to store a maximum of torsional energy.

2 Claims, 8 Drawing Figures



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SHEET 1 OF 2

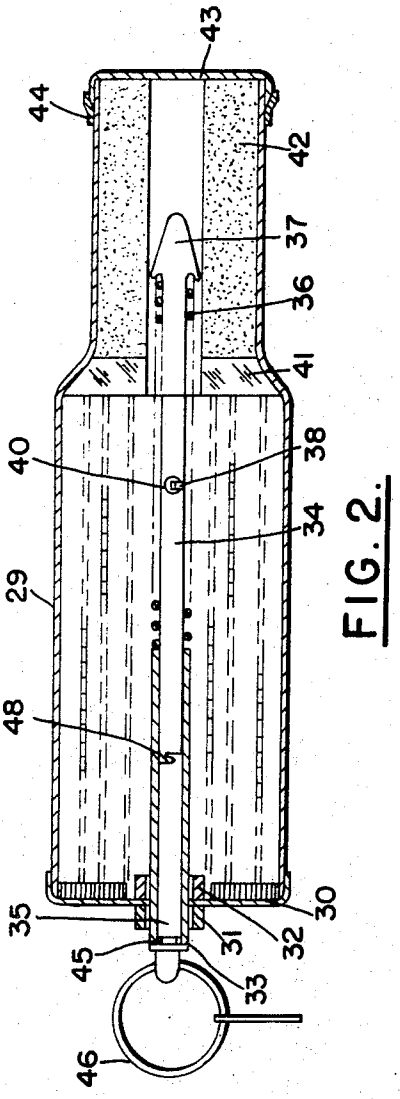


FIG. 2.

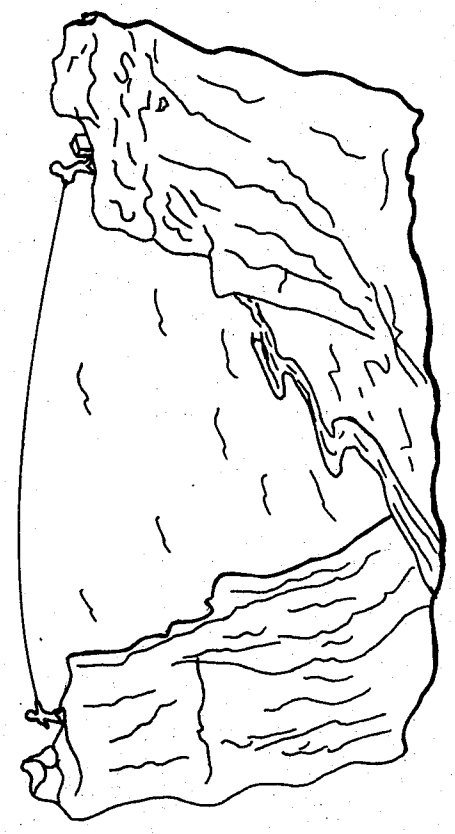


FIG. 1.

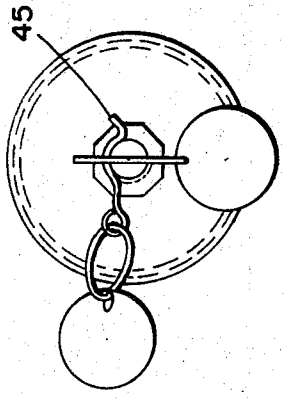


FIG. 3.



FIG. 4.

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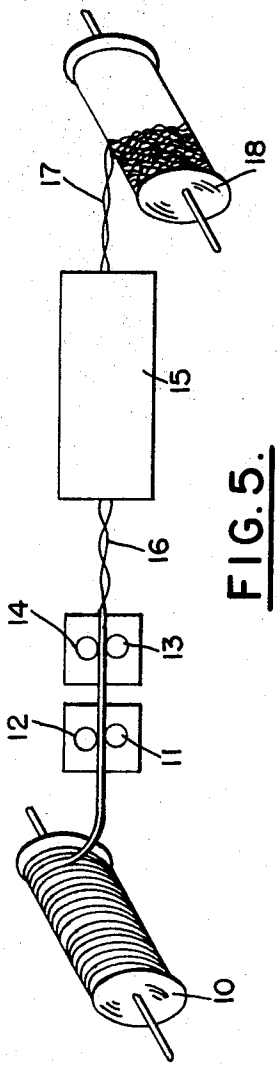


FIG. 5.

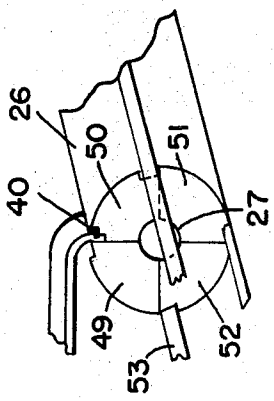


FIG. 8.

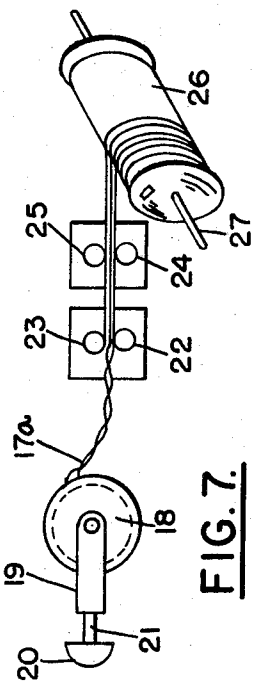


FIG. 7.



FIG. 6.

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WIRE FORMING APPARATUS

This invention is a division of my pending application Ser. No. 823,232, filed Mar. 28, 1969 which was a division of my application Ser. No. 180,058, filed Mar. 15, 1962, that issued as U.S. Pat. No. 3,470,861 on Oct. 7, 1969.

The invention described herein may be manufactured, used, and licensed by or for the Government for governmental purposes without the payment to me of any royalty.

This invention relates to apparatus for forming a wire for use in a wire gun which projects a length of about 100 feet of wire quickly under the impetus of internal torsional stresses in the wire to quickly laying a wire entanglement, a communication wire laid over flat ground, or throw a wire across a chasm preparatory to erecting a bridge, and for a multitude of other uses.

One of the objects of the invention is to provide apparatus for forming a wire where its tending to fracture is eliminated.

Another object of the invention is to provide such apparatus to form a wire having the capacity to store a maximum of torsional energy.

These objects, features and advantages will become more apparent from the following description and accompanying drawings in which:

FIG. **1** shows a use for this product in being able to shoot a wire across a chasm for communication uses, or preparatory to erecting a bridge.

FIG. **2** is a longitudinal partial section through one embodiment of this invention.

FIG. **3** is a left side view of the device of FIG. **2**.

FIG. **4** illustrates a short length of untwisted wire having barbs formed along at least one edge thereof.

FIG. **5** shows one method of making a supply reel filled with twisted wire from which internal stress has been relieved.

FIG. **6** shows a short length of twisted wire from which internal stress has been removed.

FIG. **7** exemplifies the manner of winding wire flatwise when it contains enough internal stress for its intended use.

FIG. **8** illustrates a collapsible mandrel on which the wire under torsional stress may be wound flatwise as in FIG. **7**.

The length of wire shown in FIG. **1** is shot from a coil of the type in FIG. **2** under the impetus of internal torsional stress within the wire wound flatwise to contain such internal stress.

This is accomplished by taking a supply reel **10** of soft untempered spring steel wire preferably of rectangular cross section and free of internal torsional stress as shown at reel **10** in FIG. **5**. This wire should be of about a 1,050 to 1,095 carbon content and capable of being heat treated and quenched in a manner well known in the art to have a Rockwell C hardness of about 38 to 45 with its elastic limit and ultimate strength greatly increased. The guide rolls **11** and **12** feed the untwisted soft spring wire between them from the reel **10** and function to prevent any later applied twist in the wire getting to the reel **10**. The rolls **12** and **14** are preferably spaced from rolls **11** and **12** the pitch distance of a twist and rolls **13** and **14** have their axes rotated around the wire at a rate depending on the speed of the wire. This rotation may be by hand but preferably by mechanism geared to the drive for the wire from rolls **11** and **12**. The degree of twist is preferably at a rate to impose a torsional twist upon the wire which is well above its elastic limit leaving a permanent set on the soft wire.

Within the rectangle **15** is an appropriate heater for the wire after which it is promptly quenched to harden it and raise its elastic limit and ultimate strength far above what it was previously in its untempered condition. This conventional heat treatment is familiar to those skilled in the art who know that any remaining torsional stress in the wire **16** from twisting rollers **13** and **14**, is removed by the twisting and tempering. After this heat treatment the twisted but torsionally unstressed wire **17** is wound up on reel **18**.

The twisted wire **17** is unsuitable for use in the wire gun of FIG. **1** for two reasons. It is not stressed and it is of a shape not adapted to be wound compactly in a coil. To eliminate these disadvantages they are now harmonized into a shape that may be compactly wound as well as possessed of substantial internal stress in torsion.

For that purpose the same reel **18** from FIG. **5** after being filled is transferred to a support **19** (FIG. **7**) mounted on a bearing **20** capable of allowing the reel axis to be rotated in a plane generally normal to that of the wire and through the reel axis so that torsional stress applied to wire **17***a* may enable the reel **18** to rotate about the axis of its stem **21** in the bearing **20**. It should be borne in mind that the twisted unstressed wire **17***a* coming from reel **18** is the same as that which is designated **17** in FIG. **5** as being wound upon reel **18**. The first pair of straightening rolls **22** and **23** (FIG. **7**) preferably pull the wire from reel **18** and feed it toward the mandrel **26** on which the torsionally stressed wire is wound flatwise. The second pair of straightening rolls **24** and **25** rotate in the plane of their axes to untwist the wire applying torsional stress in doing so and are located closely adjacent the wind-up mandrel **16**. These rolls **24** and **25** are preferably spaced apart as were the first pair of straightening rolls **22** and **23** or an amount equal to about a full twist so as to be spaced apart a distance enough to afford any of the torsional stress being put in the wire, a chance to make the wire become untwisted but restressed torsionally for winding flat on mandrel **26** without weakening any of the torsional stress. This restressing in torsion by untwisting the unstressed wire **17***a* is in value about half of the elastic limit of the tempered wire. This in pounds per square inch may exceed the stress imposed on the wire **16** due to the higher elastic limit imparted to the wire **17***a* by the heat treatment and quenching.

In FIG. **6** is shown a specimen of the wire **16** before being untwisted by the straightening rolls **22** to **25** inclusive. In this figure of the drawing the degree of twist is sufficient to have one full twist i.e., from a peak on one edge to a next peak on an opposite edge, about 3 inches. This wire is about 0.025 inches thick and 0.25 inches wide.

After winding a desired length of wire upon mandrel **26**, the mandrel is removed from the wound wire and from the shaft **27**. This mandrel **26** is shown in FIG. **8** as being in four parts, **49**, **50**, **51**, and **52** mounted on shaft **27**, and capable being slid longitudinally off this shaft. When these four segments are assembled on shaft **27** an elastic band not shown adjacent each end will hold these segments in place, such bands passing around the tying cords or straps **53** placed within the grooves illustrated. In starting to wind the torsionally stressed wire flatwise on the mandrel an end is given a short 90° bend **40** and placed within a slot in one end portion as shown. When a desired length has been wound the tie cords **53** are made fast to their opposite ends over the top of wound wire to securely hold the torsionally stressed layers of wire against coming off accidentally. The four parts of the mandrel are then able to be slid longitudinally off the shaft **27** leaving the coiled and stressed wire held together for insertion into one end of the housing **29** described later and shown in FIG. **2**. The inner end **40** is placed in a notch **38** in the dart **34** before the coil is inserted into housing **29**. After being inserted into the housing the tie cords may be cut and pulled out longitudinally from around the coiled wire and the end of the housing.

This housing **29** is of light weight material such as aluminum or plastic into which the coil convolutions may be slid. It has an end closed by a cap **30** clamped between two nuts **31** and **32** threaded on the light metal guide tube **33** in which is received the rear end of a dart rod **34** and a firing pin **35** secured to the dart by the somewhat S shaped connection **48** illustrated. In this way when the firing pin **35** is pulled back far enough, the right end of pin **35** becomes disconnected from the dart **34**, allowing a small helical spring **36**, engaging the front end of tube **33** and a head or forward end **37** of the dart, to be compressed and then released ejecting the dart **36** forward. A notch **38** receives an inner end of the torsionally stressed wire coil. Any notched rod may serve to carry the inner end **40** of the wire coil out of the housing for freeing the wire end **40** and allow the stressed wire to be relieved forcing the wire forward as the stress in the wire becomes freed in successive convolutions. The housing wall **41** is of foam rubber to assist in guiding the wire being ejected through the hole shown as being larger than the dart **34** and its head **37**. In front of

housing 29 and its wall 41 is an extension 42 filled with material such as excelsior or sawdust or the like capable of nevertheless exerting a slight retaining effect upon the convolutions, to protect against coil damage under shocks in handling. The light cap 43 closes the front end of the extension and a pull-off type tape 44 holds the cap in place on the front end of extension 42 of the housing 29. The cap 43 is of light enough material to be punctured by the dart in event cap 43 is not removed and has been forgotten. A soft metal safety pin 45 of the general shape shown in FIG. 3 locks the pin 35 and spring 36 against being compressed by pulling ring 46 until after this safety pin 45 has been removed from its cooperation with the groove illustrated in the firing pin 35.

In FIG. 4 is shown another type wire having barbs 47 formed by stamping along at least one edge of the wire and for use in quickly laying barbed wire entanglements for their usual uses in impeding movements of personnel. In the embodiment of FIG. 4 the wire is about 0.024 inch thick, about 0.250 inches in width including the barbs, and is twisted, heated, treated, and untwisted in applying torsional stress to the wire as described above.

The wire described when stressed during untwisting to only about half its elastic limit in torsion has been found to be capable of throwing the initially ejected end of the wire a distance of about 100 feet at a rate of about 100 feet per second. After removal of the safety pin 45 and pulling ring 46 away from the operator's other hand holding the housing 29, the dart is ejected and starts ejection of the wire. The dart or other rod falls in a few feet while the wire continues and may be used for throwing a communication wire or a wire for initially pulling a heavier wire across a chasm or depression as shown in FIG. 1. Where the ground is flat this invention is useful in quickly laying a message wire. Such a wire should be insulated with a layer only about 0.001 of an inch thick of a well plasticized plastic or an enamel applied after heat treatment and before winding on the mandrel.

Among the advantages of this may be mentioned the ability to quickly and easily lay wire entanglements and wire for communications with a range of about 100 feet with a velocity of 80 to 100 feet per second. These values are not believed to be upper limits because thicker wire should enable greater ejecting force to be available. Any shape of wire cross section may be used but the wire of rectangular cross section has the advantage of showing the degree of its permanent set when twisted and when untwisted enables the wire to be compactly wound for storage, ready for use as a wire gun or for many other purposes. The housing is light in weight, as a dispenser of wire entanglement this wire is said to have a psychological effect upon impact of the leading inner end of a coil upon personnel. Where barbed wire has heretofore been said to obstruct approach troops, this improvement may be caused to surround and attach to moving troops. The other end of the torsionally stressed wire coil needs no special holding as does the inner end of the coil but will be adequately secured when the coil snugly slides into the housing 29. The degree of Rockwell C hardness after tempering determines an elastic limit much more than double the wire strength when soft and before tempering. Space economy in winding the stressed wire flatwise is an important feature of this invention product.

A plurality of wires may be simultaneously ejected from a plurality of windings. A plurality of wires may be simultaneously wound and ejected from the same coil simultaneously with the wires nested.

I wish it to be understood that I do not desire to be limited to the exact details of construction shown and described, for obvious modifications will occur to a person skilled in the art.

I claim:

1. An apparatus for forming a wire for use in a wire gun comprising,

means for twisting a flattened steel wire to an amount above its elastic limit,

means including a heater for removing the torsional stress from said wire without untwisting it,

means for applying to said wire a torsional stress below its elastic limit and substantially reflattening the wire, and

means for winding the flattened wire into a coil with the inner end of the coil secured against becoming unwound,

said means for reflattening the wire including pairs of rolls between which untwisting of the wire is accomplished, said pairs being positioned intermediate said winding means and a reel on which the stress removed twisted wire is wound.

2. An apparatus according to claim 1 which includes a support for said reel of a type enabling the reel axis to rotate.

* * * * *