An in-line strainer for placement within a span of wire fence to apply tension thereon is provided. The in-line strainer includes a reel having a hollow central hub for receiving a torque limiting mechanism. The torque limiting mechanism includes a central axle and a spring mechanism. As the axle is manually rotated, the reel is also rotated through its engagement with the torque limiting mechanism until a target tension on the wire is reached. Once the target tension has been reached, the torque limiting mechanism disengages, allowing the axle to “slip” relative to the reel, preventing further rotation of the reel and, consequently, further tensioning of the wire. In addition, the in-line strainer includes a failure mechanism which ensures that, when the load threshold on the fence is exceeded, the in-line strainer will automatically release tension on the wire wound thereon in a predictable and safe manner.
IN-LINE STRAINER WITH TENSION CONTROL MECHANISMS FOR USE ON HIGH TENSILE WIRE

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention is related to wire fencing and, more particularly, to a device for controlling maximum tension during installation of high tensile wire fence and for providing a predictable release mechanism when tension overload occurs.

[0003] 2. Description of the Related Art

[0004] When installing high tensile wire fence, such as for livestock, it is necessary to place a specified amount of tension on the wire. Typically, this tension is applied after the wire has been strung around a fence perimeter by installing an in-line strainer at spaced locations along spans of fencing. A representative conventional in-line strainer installed on a wire extending between two fence posts is shown in Fig. 1. The use of in-line strainers to tension wire fencing is well known in the art.

[0005] A commonly recommended pre-load for high tensile fences is 250 lb of tension. To set the pre-tension of the wire, existing in-line strainer methods rely on a compression or tension indicator spring which is installed on the fence wire before it is tensioned. The tension indicator spring generally includes indicators, such as notches, that are initially obscured by the spring and thereafter become visible as the wire is tensioned and the spring is compressed. In one such spring, the appearance of a first notch indicates 150 lb of tension, and the appearance of the second notch indicates 300 lb of tension. However, “reading” the spring is often a matter of interpretation, leaving the installer uncertain as to whether the correct pre-tension level has been reached.

[0006] Regardless of whether the tension indicator spring functions effectively and is “read” correctly, current in-line strainers can be tightened beyond the recommended tension to the point of catastrophic failure in either the wire or the strainer. The manner in which the failure occurs after maximum load has been exceeded is unpredictable and random, which can result in injury to the person installing the fence or other collateral damage, as significantly tensioned parts of the strainer and/or the fence wire are suddenly released to effectively act as high-speed projectiles. Similarly, even if the fence wire is properly tensioned, over-tensioning can occur during use, such as by a livestock-imposed load on the fence, which again results in unpredictable and random forms of wire and/or tensioning mechanism failure.

[0007] Accordingly, a need exists for an in-line strainer that can be used to effectively tension wire fencing to the recommended pre-load while preventing over-tensioning during installation. A need also exists for an in-line strainer that, when subjected to excess loads on the fence wire following installation, breaks in a predictable, repeatable and safe manner.

SUMMARY OF THE INVENTION

[0008] In view of the foregoing, the present invention is directed to an in-line strainer for placement within a span of wire fence to apply tension thereto. The in-line strainer includes a reel, rotatably supported by a body, for spooling up the fence wire during tensioning. The reel is provided with external teeth that engage a pawl which is supported by the body and held by spring tension against the reel to prevent the reel from unwinding. The center of the reel has an inner wall that defines a hollow center portion for receiving a torque limiting mechanism. The torque limiting mechanism includes a central axle and a spring mechanism and, when engaged with the reel, transfers rotational force from the axle to the reel. Specifically, as the axle is manually rotated, the reel is also rotated through its engagement with the torque limiting mechanism until the target tension on the wire is reached. Once the target tension has been reached, the torque limiting mechanism disengages, allowing the axle to “slip” relative to the reel, preventing further rotation of the reel and, consequently, further tensioning of the wire.

[0009] In one preferred embodiment, the torque limiting mechanism includes at least one detent operative with the spring mechanism that is received within at least one notch in the inner wall of the reel when the torque limiting mechanism is engaged. When the force needed to turn the reel becomes greater than the resistance created by the detent’s position within the notch, the axle rotates relative to the reel and the detent moves out of the notch to disengage the torque limiting mechanism. Preferably, the “slipping” movement of the torque limiting mechanism relative to the reel produces audible and tactile feedback to the installer that the disengagement has occurred.

[0010] The present invention further includes a failure mechanism which ensures that, when the load threshold on the fence is exceeded, the in-line strainer will break or otherwise release in a predictable and safe manner. In one preferred embodiment, the failure mechanism includes a line of weakness such as a notch in the side of the pawl. When the wire tension is too great, the pawl will fold or fracture along the line of weakness, allowing the reel to unwind which releases the tension on the wire.

[0011] Accordingly, it is an object of the present invention to provide an in-line strainer that overcomes the difficulties encountered with prior art devices when trying to achieve an accurate pre-load on high tensile fences, the present invention including a reel with a torque limiting mechanism that prevents the wire from being tensioned beyond the desired pre-tension level.

[0012] Another object of the present invention is to provide an in-line strainer in accordance with the preceding object in which the reel has a hollow central hub and the torque limiting mechanism includes a central axle with a spring mechanism fitted within the center of the reel that rotates with the reel when the torque limiting mechanism is engaged and that slips relative to the reel when the torque limiting mechanism is disengaged.

[0013] A further object of the present invention is to provide an in-line strainer in accordance with the preceding objects in which the reel has external teeth that are engaged by a pawl to keep the reel from unwinding, the pawl having a failure mechanism that ensures that the in-line strainer will break in a predictable and safe manner when tension on the wire exceeds maximum safe load.

[0014] Yet another object of the present invention is to provide an in-line strainer in accordance with the preceding objects in which the failure mechanism includes a notch in the side of the pawl that forms a line of weakness along which the pawl will fold or fracture when tension on the wire exceeds maximum safe load.

[0015] A still further object of the present invention is to provide an in-line strainer in accordance with the preceding
objects in which the torque limiting mechanism includes a notch formed in an inner wall of the reel’s hollow central hub, and a detent operative with the spring mechanism that fits within the notch when the mechanism is engaged and moves out of the notch to disengage the mechanism.

Yet another object of the present invention is to provide an in-line strut herein the preceding objects in which the movement of the detent out of the notch produces audible or tactile feedback to the fence installer of the disengagement.

Another object of the present invention is to provide an in-line strut in accordance with the preceding objects that is not complex in structure and which can be manufactured at low cost but yet effectively prevents wire fencing from being tensioned beyond a desired pre-tension during installation and, during use, provides for safe and predictable failure when maximum safe load on the fence wire is exceeded.

These together with other objects and advantages which will become subsequently apparent reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a conventional in-line strutter installed on a wire extending between two fence posts.

FIG. 2 is a perspective view of an in-line strutter in accordance with a first embodiment of the present invention.

FIG. 3 is an exploded view of the in-line strutter shown in FIG. 2.

FIG. 4 is a perspective view of one of the straps shown in FIG. 3, as viewed from the outer side with respect to the assembly shown in FIG. 2.

FIG. 4A is a top view of the strap shown in FIG. 4.

FIG. 4B is a side view of the strap shown in FIG. 4, as viewed from the inner side with respect to the assembly shown in FIG. 2.

FIG. 4C is a cross sectional view taken along line A-A of FIG. 4B.

FIG. 4D is an enlarged view of the area denoted Detail D in FIG. 4C.

FIG. 4E is a cross sectional view taken along line B-B of FIG. 4B.

FIG. 4F is an end view of the strap shown in FIGS. 4 and 4D.

FIG. 5 is a perspective view of the reel shown in FIG. 3, as viewed from the axle-insertion side, designated herein as the right side and as shown in FIGS. 2 and 3.

FIG. 5A is a perspective view of the reel shown in FIG. 5 from the left side.

FIG. 5B is another perspective view of the reel shown in FIG. 5 from the right side and rotated 90°.

FIG. 5C is a view of the right side of the reel shown in FIG. 5.

FIG. 5D is a view of the left side of the reel shown in FIG. 5.

FIG. 5E is an end view of the reel shown in FIG. 5.

FIG. 5F is a cross sectional view taken along line A-A of FIG. 5E.

FIG. 5G is an end view of the reel shown in FIG. 5.

FIG. 5H is a cross sectional view taken along line C-C of FIG. 5G.

FIG. 6 is a perspective view of the axle shown in FIG. 3, as viewed from the axle-tightening side, designated herein as the right side and as shown in FIGS. 2 and 3.

FIG. 6A is a perspective view of the axle shown in FIG. 6 from the left side.

FIG. 6B is a top view of the axle shown in FIG. 6.

FIG. 6C is a side view of the axle shown in FIG. 6.

FIG. 6D is an end view from the left side of the axle shown in FIG. 6C.

FIG. 6E is an end view from the right side of the axle shown in FIG. 6C.

FIG. 7 is a perspective view of the spring mechanism shown in FIG. 3.

FIG. 7A is a side view of the spring mechanism shown in FIG. 7.

FIG. 7B is a top view of the spring mechanism shown in FIG. 7.

FIG. 8 is a perspective view of the detent embodied as a dowel pin as shown in FIG. 3.

FIG. 8A is a side view of the dowel pin shown in FIG. 8.

FIG. 8B is an enlarged view of the area denoted Detail B in FIG. 8A.

FIG. 8C is an end view of the dowel pin shown in FIG. 8A.

FIG. 9 is a perspective view of the pawl as shown in FIG. 3.

FIG. 9A is a top view of the pawl as shown in FIG. 9.

FIG. 9B is a side view of the pawl shown in FIG. 9A.

FIG. 9C is an end view of the pawl shown in FIG. 9A.

FIG. 10 is a perspective view of the pawl spring as shown in FIG. 3.

FIG. 10A is a side view of the pawl spring shown in FIG. 10.

FIG. 10B is an end view from the left side of the pawl spring shown in FIG. 10A.

FIG. 10G is a view of the pawl spring shown in FIG. 10 as rotated 90° on a horizontal axis.

FIG. 10D is a top view of the pawl spring shown in FIG. 10A.

FIG. 11 illustrates the basic components of a torque limiting mechanism having an axle, a spring mechanism and a detent, in accordance with the present invention.

FIG. 12 illustrates a modified version of the torque limiting mechanism shown in FIG. 11, having an axle, spring mechanism and two detents.

FIG. 13 illustrates a conventional tool used to turn the reel of an in-line strutter to tension a fence wire.

FIG. 14 shows a detent sequentially engaged in a notch, beginning to disengage, and then disengaged from the notch in accordance with the operation of a torque limiting mechanism of the present invention.

FIG. 15 is a perspective view of an assembled in-line strutter in accordance with a second embodiment of the present invention.

FIG. 16 is an exploded view of the in-line strutter shown in FIG. 15.

FIG. 17 is an assembled view of a third embodiment of a torque limiting mechanism in accordance with the present invention.
FIG. 18 is an exploded view of the third embodiment components shown in FIG. 17.

FIG. 19 is a side view of the torsion spring installed in the reel of the embodiment shown in FIG. 17.

FIG. 20 is an assembled view of a fourth embodiment of a torque limiting mechanism in accordance with the present invention.

FIG. 21 is an exploded view of the fourth embodiment components shown in FIG. 20.

FIG. 22 is a side view of the key and spring installed in the reel of the embodiment shown in FIG. 20.

FIG. 23 is an assembled view of a fifth embodiment of a torque limiting mechanism in accordance with the present invention.

FIG. 24 is an exploded view of the fifth embodiment components shown in FIG. 23.

FIG. 25 is a side view of the clutch limiter installed in the reel of the embodiment shown in FIG. 23.

FIG. 26 is an assembled view of a sixth embodiment of a torque limiting mechanism in accordance with the present invention.

FIG. 27 is an exploded view of the sixth embodiment components shown in FIG. 26.

FIG. 28 is a side view of the clutch limiter installed in the reel of the embodiment shown in FIG. 26.

FIG. 29 is an assembled view of a seventh embodiment of a torque limiting mechanism in accordance with the present invention.

FIG. 30 is an exploded view of the seventh embodiment components shown in FIG. 29.

FIG. 31 is a side view of the clutch limiter installed in the reel of the embodiment shown in FIG. 29.

FIG. 32 is a side view of a notched pawl failure mechanism in accordance with the present invention.

FIG. 33 depicts the notched pawl failure mechanism of FIG. 2 upon failure.

FIG. 34 is an isolated perspective view of the broken pawl shown in FIG. 33.

FIG. 35 is a perspective view of an alternate embodiment of a notched pawl in accordance with the present invention.

FIG. 35A is a planar view of the pawl shown in FIG. 35A.

FIG. 35C is a side view of the pawl shown in FIG. 35A.

FIG. 36 is a perspective view of a further embodiment of a notched pawl half in accordance with the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In describing a preferred embodiment of the invention illustrated in the drawings, specific terminology will be resorted to for the sake of clarity. However, the invention is not intended to be limited to the specific terms so selected, and it is to be understood that each specific term includes all technical equivalents which operate in a similar manner to accomplish a similar purpose.

As shown by a first embodiment in FIGS. 2 and 3, and in more detail on a component by component basis in FIGS. 4-10C, the present invention is directed to an in-line strainer, generally designated by reference numeral 10, for placement within a span of wire fence to apply tension thereto. The in-line strainer 10 includes a body or strap generally designated by reference numeral 12, a reel 14, a torque limiting mechanism generally designated by reference numeral 16, and a reel holding mechanism generally designated by reference numeral 18.

The strap 12 can be a unified member or, as shown in FIGS. 3, 4 and 4A-4F, may be comprised of two separate strap members 12a and 12b that are connected to one another when the strainer is assembled as shown in FIG. 2. The two strap members are identical which facilitates ease of manufacture, with each strap member having a body 20 with an axle mounting aperture 22, a pawl mounting aperture 24, a pair of pawl spring mounting loops 26, and a fence wire mounting aperture 28, as will be described more fully hereinafter. The body 20 has a curved portion 30 that enables the respective fence wire mounting apertures 28 of two strap members, as assembled, to be in abutment with one another while the axle mounting apertures 22 and pawl mounting apertures 24 of such strap members are spaced apart to provide room therewithin for the reel 14 and reel holding mechanism 18, respectively.

As is conventional, the reel 14 includes a plurality of external teeth 32 separated from one another by hollows 34 and is rotatably supported by the pair of strap members 12. When the strainer is installed along a wire span, the wire is cut to create two ends (see FIG. 1). The first wire end 33 is secured to the strap by passing the wire through the fence wire mounting apertures 28 and crimping the wire upon itself at crimp 31 (see FIG. 13). The second wire end 35 is inserted through a wire hole 36, preferably on one side of the reel hub 15 (see FIGS. 3 and 5B), and bent to secure the wire to the reel prior to tensioning of the wire. Such installation steps are well known in the art.

According to the first embodiment of the present invention, the hub 15 of the reel 14 has a hollow central portion generally designated by reference numeral 40, defined by an inner wall 42 having a plurality of notches 44 spaced around the inner wall 42 and separated from one another by high points 46. Several views of the reel 14 are provided in FIGS. 5 and 5A-5H. As best shown in FIGS. 5A, 5B and 5F; the notches 44 do not extend all the way through the reel so as not to interfere with securing the wire end 35 inside the reel hub 15. Other configurations of the hollow central portion 40 are also possible, some of which are shown and discussed hereinafter.

The torque limiting mechanism 16 includes a central axle generally designated by reference numeral 50, a spring mechanism generally designated by reference numeral 52, and a detent generally designated by reference numeral 54. While only one detent is illustrated in FIG. 3, there are in fact two detents in this embodiment, with one detent being positioned on either end of the spring mechanism.

According to the first embodiment, the axle 50 has a longitudinally extending body 56 that extends at least partly through the central portion 40 of the reel. The body 56 has a central channel 58 that passes through the body 56 transversely to the longitudinal axis of the axle 50 as shown in FIGS. 6 and 6A-6E. The ends of the axle 50, in longitudinal alignment with and on either side of the body 56, include tool engagement heads 60, 62 for operative engagement with a correspondingly designed tool used to rotate the axle 50 as will be discussed hereinafter. One such tool being used to rotate a conventional reel is shown in FIG. 13.

The spring mechanism 52, shown in FIGS. 7, 7A and 7B, is received within the central channel 58. According
to the first preferred embodiment, the spring mechanism 52 is a polyurethane member, although other flexible materials that meet the release force requirements for achieving proper tension on the wire could also be used. Other alternative constructions for the spring mechanism 52 include a compression spring, torsion spring, Belleville springs, or other comparable spring mechanisms.

[0097] The detents 54 can also be variously configured as will be discussed hereinafter. In the first embodiment shown in FIGS. 2, 3, 8, 8A, and 8B, the detents are dowel pins positioned adjacent each of the ends of the polyurethane member spring mechanism 52. The detents 54 preferably have chamfered ends 64 to facilitate insertion of the axle 50, spring mechanism 52 and detents 54 into the hollow central portion 40 of the reel 15 during assembly, but chamfering the ends is not necessary.

[0098] When the torque limiting mechanism 16 is inserted into the hollow center portion 40 of the reel 14 upon assembly of the in-line strainer 10 as shown in FIG. 2, the detents 54 are configured to engage with the notches 44 formed in the inner wall 42 of the reel, under the compression force provided by the spring mechanism 52. When rotational force is exerted on the axle tool engagement heads 60, 62, the axle rotates and, through the engagement of the detents 54 and the reel notches 44, the reel also rotates. The stiffness of the spring mechanism, the materials from which the reel inner wall and the detents are made, and the shape of the detents determine the resistance of the torque limiting mechanism 16 to disengagement. These parameters may be adjusted during manufacture to obtain the desired threshold at which the torque limiting mechanism will begin to “slip” relative to the reel.

[0099] While being rotated by the axle, the reel is prevented from unwinding by the reel holding mechanism 18. The reel holding mechanism 18 includes a pawl generally designated by reference numeral 70 and shown in detail in FIGS. 9 and 9A-9C, and a pawl spring generally designated by reference numeral 72 and shown in detail in FIGS. 10 and 10A-10D.

[0100] The pawl 70 has an axle 74 coupled to a flap 76 that has at least one reel-engagement arm 78 that is received within one of the reel hollows 34 between the external teeth 32. Preferably, the pawl 70 has two reel-engagement arms 78, each of which engage one side of the reel. The pawl axle 74 is pivotably mounted to the strap members 12 by inserting the axle ends 80 through the pawl mounting apertures 24. As the reel 14 is rotated, the flap 76, rotating on the pawl axle 74, moves the reel-engagement arm 78 from one reel hollow 34 to an adjoining hollow in sequence. The sides 29 (see FIG. 5C) of the reel teeth 32 are sloped to facilitate this movement of the arm 78 as it slides along the side 29 of the tooth 32 before dropping into the next adjoining hollow 34 as the reel rotates. Once the arm drops into a hollow, the reel is prevented from unwinding by the pawl 70.

[0101] To ensure that the pawl 70 moves into and stays engaged within the reel hollows 34, the pawl spring 72 exerts a spring force on the pawl flap 76 to force the arm 78 against the reel 14. The ends 82 of the pawl spring 72 are secured in the pawl spring mounting loops 26 formed on the inward facing sides of the strap 12, while the middle portion 84 of the pawl spring 72 presses against the pawl flap 76.

[0102] In operation, the torque limiting mechanism 16, when mounted within the reel 14 in the assembled strainer, transfers rotational force from the axle 50 to the reel 14. The fence installer tightens the reel by turning the axle 50 using an appropriate tool as applied to the tool engagement heads 60, 62 on the axle. As the axle is manually rotated, the reel is also rotated through its engagement with the torque limiting mechanism 16 until the target tension on the wire is reached. This target tension is determined by the specific construction of the in-line strainer, taking into account the materials used, the depth of the notches, the shape of the detent, etc. Once the target tension on the wire has been reached, the force needed to turn the reel becomes greater than the resistance created by the position of the detents 54 within the opposed notches 44. At this point, further rotation of the axle 50 causes each detent to move out of its notch into the next adjoining notch, thus effectively “disengaging” the torque limiting mechanism. If the operator continues to try to tension the wire, the detents of the torque limiting mechanism will continue to ratchet from one notch to the next, allowing the axle to “slip” relative to the reel so that further tensioning of the wire is prevented.

[0103] Preferably, the movement of the detents out of the notches produces audible or tactile feedback to the installer of the disengagement. Such feedback informs the installer that the in-line strainer is operating properly and that the desired tension has indeed been achieved.

[0104] While the above-described first embodiment includes two detents 54, it should be noted that in its most basic form a single detent may be satisfactory. As illustrated in FIG. 11, the torque limiting mechanism according to the present invention generally designated by reference numeral 100 includes a central axle 150, a spring mechanism generally designated by reference numeral 152, and a single detent generally designated by reference numeral 154. Alternatively, a slightly more complex torque limiting mechanism, generally designated by reference numeral 110, can include an axle 151, a spring mechanism 153 and a pair of detents 154, 155 as shown in FIG. 12: the first embodiment shown in FIGS. 2 and 3 is an example of such a paired detent configuration.

[0105] The torque limiting mechanism can also be made with three or more detents through appropriate placement of a second and/or third spring mechanism, or more, with the detents being spaced around the perimeter of the axle. It would even be possible to have as many detents as there are notches in the inner wall of the reel. The number of detents that is preferred depends upon the materials from which the reel, the detents and the spring mechanism are made; the shape and size of the detents; and the load to be placed on the wire being tensioned. However, the present invention only requires a single notch and a single detent to work effectively.

[0106] The central channel 159 in the axle 151 can pass all the way through the axle as shown in FIG. 12 and according to the first embodiment, or the central channel 158 can extend only partly through the axle as shown in FIG. 11. In either case, the spring mechanism 152, 153 is received within the central channel 158, 159, with a detent 154 being positioned on one end of the spring mechanism 152 in the case of one detent (FIG. 11), or with the detents 154, 155 positioned on each end of the spring mechanism 153 in the case of two detents (FIG. 12).

[0107] The stages by which a detent 154 moves out of a correspondingly shaped notch 144 to disengage the torque limiting mechanism are illustrated in FIG. 14. As shown, in the initial stage, identified as “1” in FIG. 14, the detent has full or nearly full face contact with the notch; complete full face contact may not occur due to manufacturing variation. As the force needed to turn the reel increase, the detent 154 begins to slip relative to the notch as shown in the stage marked “2”.
Finally, when the force needed to turn the reel becomes greater than the resistance created by the position of the detent 154 within the opposed notch 144, the detent moves out of the notch 144 as shown in the stage marked “3”. At this point, further rotation of the axle 150 does not result in further rotation of the reel.

[0108] Assembled and exploded views of a second embodiment of an in-line strainer according to the present invention, generally designated by reference numeral 200, are shown in FIGS. 15 and 16, respectively. As in the first embodiment, the in-line strainer 200 includes a body or strap generally designated by reference numeral 212a, a reel 214a, a torque limiting mechanism generally designated by reference numeral 216, and a reel holding mechanism generally designated by reference numeral 218. As these components operate in a manner like that already described in connection with the first embodiment, description of these components will not be repeated except to identify differences with respect to the first embodiment. Also, elements of the same basic type as used in each of the embodiments are designated in the particular embodiments that follow with the same two-digit number as in the first embodiment but preceded by a “2” for the second embodiment, a “3” for the third embodiment, etc.

[0109] In the second embodiment, the side straps 212a, 212b have a different configuration from those shown in the first embodiment, but their operation remains the same. In the second embodiment the straps are designed to be snapped together, but alternatively may be welded together as in the first embodiment. The straps may also be screwed or riveted to one another, or connected using other fastening devices as would be understood by persons of ordinary skill in the art.

[0110] In addition, the side straps 212a, 212b include an integrated spring element 272 that forms part of the reel holding mechanism 218 along with the pawl 270. For ease of manufacture, both side straps 212a, 212b are of identical construction. Therefore, the spring element 272 that ends up on the bottom of the in-line strainer when two of the side straps are connected to one another is extraneous in terms of function, while the upper spring element 272 applies spring tension to the pawl 270. Rather than dowel pins, the detents in the second embodiment are embodied as keys 254 having a flat lower surface 255 that abuts with the spring mechanism 252 and a rounded upper surface 257 that engages with the notches 244 in the inner wall 242 of the reel 214. The inner wall 242 of the reel 214 only has two notches 244, rather than the multiplicity of notches spaced all around the inner wall 242 of the reel 214, as in the first embodiment. Hence, in the second embodiment, the axle 250 can turn nearly 180 degrees upon disengagement of the detents 254 with the notches 244. As this degree of movement upon disengagement can be disruptive or startling to the installer, the multiplicity of spaced notches around the reel as provided in the first embodiment, which limits release movement to a small increment, is preferred.

[0111] As shown, the torque limiting mechanism in both the first and second embodiments have similar features, including a polyurethane member and keys or dowels that are held between the urethane member and the notches in the reel to provide engagement between the axle and the reel. Various other configurations of the torque limiting mechanism are also provided according to the present invention as will now be described.

[0112] FIGS. 17-19 illustrate a third embodiment of the torque limiting mechanism according to the present invention, which is generally designated by reference numeral 300. As in the first and second embodiments, the torque limiting mechanism 300 includes an axle 350 that is received within the hollow center 340 of the reel 314. Rather than the urethane member and keys/dowels, the third embodiment relies upon a torsion spring 352. A first end 353 of the torsion spring 352 is locked to the axle 350, such as by a longitudinal slot 351. The second end of the torsion spring includes a detent 354, which engages in the notch 344 in the inner wall 242 of the reel 314. As with the dowel pins and keys of the first and second embodiments, the detent 354 of the torsion spring 352 pops out of the notch 344 when the target torque limit on the axle is exceeded, allowing the axle 350 to turn relative to the reel 314.

[0113] A fourth embodiment of the torque limiting mechanism according to the present invention is illustrated in FIGS. 20-22 and generally designated by reference numeral 400. The fourth embodiment is similar to the second embodiment, except that only a single key 454 is used as was representatively shown in FIG. 11.

[0114] A fifth embodiment of the torque limiting mechanism in accordance with the present invention is illustrated in FIGS. 23-25 and generally designated by reference numeral 500. A compression spring 552 is sandwiched between two pressure plates 553 and secured within the hollow central portion 540 of the reel by nuts 550. The pressure plates 553 are provided with peripheral detents 554 that engage corresponding notches 544 in the reel inner wall 542. A shoulder screw 557 is inserted through aligned apertures 559 in the pressure plates 553 and twisted to compress the spring 552. Upon sufficient compression of the spring, the detents 554 on the pressure plates will disengage from the reel notches 544 in a manner similar to the previous embodiments.

[0115] A sixth embodiment of the torque limiting mechanism according to the present invention is illustrated in FIGS. 26-28 and generally designated by reference numeral 600. In this embodiment, the axle is formed by two nuts 650 which serve as the tool engagement heads on either side of the reel 614. A urethane spring 652 is inserted into the bore 651 of each of the nuts 650 and then tightened to the desired degree with a respective shoulder screw 657. The nuts 650 are rotated to turn the reel 614 and tension the wire until the springs 652 exceed the frictional forces preventing rotation and allow “slip” within the bores.

[0116] A seventh embodiment of the torque limiting mechanism in accordance with the present invention is illustrated in FIGS. 29-31 and generally designated by reference numeral 700. This embodiment operates similarly to the sixth embodiment, except that the axle does not go all the way through the reel 714. Belleville springs 752 are compressed by shoulder screw 757 until interference surfaces 754 acting as detents “slip” relative to an engagement surface 759 in the center of the reel 714.

[0117] Other embodiments are also contemplated that would operate in a similar manner to limit the amount of tension that can be applied to a strand of wire. In each case, an axle is operative with the reel of the in-line strainer to rotate with the reel up to a desired torque and to then be released from the reel to rotate independently therefrom so that further rotation of the reel, and subsequent tensioning of the wire, is prevented.

[0118] The in-line strainer of the present invention further includes an integral release or failure mechanism which causes the strainer to release when a predetermined load on
the fence wire is exceeded. The failure mechanism thus ensures that, when the load threshold on the fence wire is exceeded, the in-line strainer will break or otherwise release in a predictable and safe manner to release the tension on the wire. Since the in-line strainer according to the present invention is designed to prevent over-tensioning of the wire during initial installation, the failure mechanism is provided with an eye toward controlling tension on the fence and in-line strainer during actual use.

As shown in Figs. 3 and 9 and previously described in connection with the first embodiment, the pawl 70 has an axle 74, a flap 76 and at least one reel-engagement arm 78. As shown in Fig. 9b, one side 86 of the flap is provided with a stress point such as a notch 88. The pawl may be positioned so that the notched side 86 faces upwardly as in Fig. 32. The notched side 86 may alternatively be positioned to face downwardly as shown in Figs. 3 and 9. The notch 88 creates a line of weakness along which the pawl 70 will fold or fracture when the wire tension is too great. Upon folding or fracturing of the pawl 70 along the line of weakness formed by the notch 88, as shown in Figs. 33 and 34, the reel 14 is free to unwind which releases the tension on the wire.

An alternate embodiment of the pawl is shown in Figs. 35A-35C and generally designated by reference numeral 170. In this embodiment, the outer edge 178 of the flap 176 serves as the reel-engagement arm. A further embodiment generally designated by reference numeral 270, shown in Fig. 36, includes a reel-engagement pin 278 positioned opposite and generally parallel with the pawl axle 274.

The release or failure mechanism according to the present invention could also be embodied so that, rather than breaking, the pawl or an associated component automatically “kicks out” of engagement with the reel in response to a tension overload on the wire.

The foregoing descriptions and drawings should be considered as illustrative only of the principles of the invention. The invention may be configured in a variety of shapes and sizes and is not limited by the dimensions of the preferred embodiment. Numerous applications of the present invention will readily occur to those skilled in the art. Therefore, it is not desired to limit the invention to the specific examples disclosed or the exact construction and operation shown and described. Rather, all suitable modifications and equivalents may be resorted to, falling within the scope of the invention.

What is claimed is:

1. An in-line strainer for tensioning wire fencing comprising:
   a body rotatably supporting a reel onto which fence wire is wound to tension said fence wire, said reel having a plurality of alternating external teeth and notches;
   a pawl pivotally mounted to said body for engaging said notches on said reel to prevent said reel from unwinding as said fence wire is tensioned; and
   a torque limiting mechanism engaged with said reel and configured to rotate said reel up to a threshold wire tension, said torque limiting mechanism disengaging from said reel when said threshold wire tension is reached so that further winding rotation of said reel is prevented.

2. The in-line strainer as set forth in claim 1, wherein said reel has a hollow center portion and said torque limiting mechanism includes an axle and a spring mechanism received within said hollow center portion, rotation of said axle concurrently rotating said reel through engagement of said spring mechanism with said reel center portion until rotational force required to rotate said axle exceeds a resistance provided by said engagement.

3. The in-line strainer as set forth in claim 2, wherein said torque limiting mechanism further includes a detent positioned between said spring mechanism and an inner wall of said hollow center portion, said inner wall including at least one notch into which said detent is engaged or to provide said resistance while said torque limiting mechanism is engaged.

4. The in-line strainer as set forth in claim 2, wherein said axle includes a through-passing channel, said spring mechanism being received within said channel, said torque limiting mechanism further including a pair of detents positioned on either side of said spring mechanism and against an inner wall of said hollow center portion, said inner wall including at least two opposed notches into which said detents are received to provide said resistance while said torque limiting mechanism is engaged.

5. The in-line strainer as set forth in claim 4, wherein said inner wall includes a regular alternating pattern of notches and high points regularly spaced around said inner wall, said detents moving from one pair of notches to a next sequential pair of notches upon disengagement of said torque limiting mechanism, said movement creating at least one tactile and audible feedback to a fence installer tensioning said fence wire each time the detents move to a subsequent pair of notches.

6. The in-line strainer as set forth in claim 1, wherein said in-line strainer further includes a failure mechanism that breaks in a predictable and repeatable manner when said threshold wire tension is exceeded.

7. The in-line strainer as set forth in claim 6, wherein said failure mechanism includes a line of weakness being substantially parallel with an axis of rotation of said reel.

8. The in-line strainer as set forth in claim 7, wherein said line of weakness is formed by a notch in an upper surface or a lower surface of said pawl.

9. In an in-line strainer for tensioning wire fencing, said in-line strainer having a body rotatably supporting a reel onto which fence wire is wound to tension said fence wire, a reel having a plurality of alternating external teeth and notches, and a pawl pivotally mounted to said body for engaging said notches on said reel to prevent said reel from unwinding as said fence wire is tensioned, the improvement comprising:
   said reel having a hollow center portion; and
   a torque limiting mechanism engaged within said hollow center portion and configured so that rotation of said torque limiting mechanism concurrently rotates said reel up to a threshold wire tension, said torque limiting mechanism disengaging from said reel to rotate separately therefrom when said threshold wire tension is reached so that further rotation of said reel is prevented.

10. The in-line strainer improvement as set forth in claim 9, wherein said torque limiting mechanism includes an axle and a spring mechanism received within said hollow center portion, rotation of said axle concurrently rotating said reel through the engagement of said spring mechanism with an inner wall of said center portion until rotational force required to rotate said axle exceeds a resistance provided by said engagement.

11. The in-line strainer improvement as set forth in claim 10, wherein said torque limiting mechanism further includes a detent positioned between said spring mechanism and said
inner wall, said inner wall including at least one notch into which said detent is received to provide said resistance while said torque limiting mechanism is engaged.

12. The in-line strainer improvement as set forth in claim 10, wherein said axle includes a through-passing channel, said spring mechanism being received within said channel, said torque limiting mechanism further including a pair of detents positioned on either side of said spring mechanism and against said inner wall, said inner wall including at least two opposed notches into which said detents are received to provide said resistance while said torque limiting mechanism is engaged.

13. The in-line strainer improvement as set forth in claim 12, wherein said inner wall includes a regular alternating pattern of notches and high points regularly spaced around said inner wall, said detents moving from one pair of notches to a next sequential pair of notches upon disengagement of said torque limiting mechanism, said movement creating at least one of tactile and audible feedback to a fence installer tensioning said fence wire each time the detents move to a subsequent pair of notches.

14. The in-line strainer improvement as set forth in claim 9, wherein said in-line strainer further includes a failure mechanism that breaks in a predictable and repeatable manner when said threshold wire tension is exceeded.

15. The in-line strainer as set forth in claim 14, wherein said failure mechanism includes a line of weakness in said pawl, said line of weakness being substantially parallel with an axis of rotation of said reel.

16. The in-line strainer as set forth in claim 15, wherein said line of weakness is formed by a notch in an upper surface or a lower surface of said pawl.

17. An in-line strainer for controlling tension on wire fencing comprising:

a body rotatably supporting a reel onto which fence wire is wound to tension said fence wire, said reel having a plurality of alternating external teeth and notches;
a pawl pivotally mounted to said body for engaging said notches on said reel to prevent said reel from unwinding as said fence wire is tensioned; and
a failure mechanism associated with said pawl that releases tension on the fence wire in a predictable and repeatable manner when a predetermined threshold wire tension is exceeded.

18. The in-line strainer as set forth in claim 17, wherein said failure mechanism includes a line of weakness in said pawl along which the pawl breaks when the predetermined threshold wire tension is exceeded, said line of weakness being substantially parallel with an axis of rotation of said reel.

19. The in-line strainer as set forth in claim 18, wherein said line of weakness is formed by a notch in an upper surface or a lower surface of said pawl.

20. The in-line strainer as set forth in claim 17, further comprising a torque limiting mechanism engaged with said reel and configured to rotate said reel up to said threshold wire tension, said torque limiting mechanism disengaging from said reel when said threshold wire tension is reached so that further winding rotation of said reel is prevented.

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