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HIGH IMPACT STRENGTH LIGHTED NOCK ASSEMBLY

Abstract

A matched arrow set including a first arrow and a second arrow. The first arrow including: a first shaft, a first bushing coupled to the first shaft, and a first nock received in the first bushing. The second arrow including: a second shaft, a second bushing coupled to the second shaft, and a second nock received in the second bushing. The first shaft and the first bushing define a first weight, the second shaft and the second bushing define a second weight greater than the first weight, and a first arrow weight is substantially the same as a second arrow weight.

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Background/Summary

REFERENCE TO RELATED APPLICATIONS [0001] The present application is a continuation of U.S. application Ser. No. 18/097,141, filed on Jan. 13, 2023, now U.S. Pat. No. 12,215,961 which is a continuation of U.S. application Ser. No. 17/366,596, filed on Jul. 2, 2021, now U.S. Pat. No. 11,555,676, which is a continuation of U.S. application Ser. No. 16/237,034, filed on Dec. 31, 2018, now U.S. Pat. No. 11,054,227, which is a continuation of U.S. application Ser. No. 15/631,016, filed Jun. 23, 2017, now U.S. Pat. No. 10,203,186, which claims the benefit of U.S. Provisional Application No. 62/459,421, filed Feb. 15, 2017 and U.S. Provisional Application. No. 62/492671, filed May 1, 2017, the entire disclosures of which are hereby incorporated by reference.

FIELD OF THE INVENTION
[0002] The present disclosure is directed to a lighted nock constructed from a transparent or semi-transparent, reinforced, high impact strength polymeric material (or blend of polymeric materials) for use in bows and crossbows.
BACKGROUND
[0003] Lighted arrow nocks, such as disclosed in U.S. Pat. No. 8,777,786 (Bay) and U.S. Pat. No. 9,279,649 (Bay), allow an archer to be able to more easily see the arrow in flight, see the point of arrow impact, and recover the arrow after a shot. Being able to observe the arrow in flight and see the point of impact helps the archer to diagnose problems with shooting form or bow setup and make appropriate adjustments. Perhaps more importantly, a lighted arrow nock allows an archer to more easily recover the arrow.
[0004] Bow hunters can especially benefit from using an arrow with a lighted nock device. Recovering an arrow that was shot at an animal is critical in the ethical harvest of animals, and a lighted nock device allows a bow hunter to recover the arrow and animal more easily. Upon recovering the arrow, the bow hunter can diagnose many things about the shot by inspecting the arrow.
[0005] As vertical bows and crossbows (referred to collectively herein as “bows”) have gotten more powerful current lighted nock products have demonstrated an inability to handle the forces generated during launch. If a nock breaks on launch the energy stored in the bow is not absorbed (or is only partially absorbed) by the arrow, resulting in a fill or partial “dry fire” event. In a dry fire event some or all of the energy stored by the bow is absorbed by the bow itself, especially the limbs and the riser. Shattered limbs and crack risers are common outcomes of a dry fire event. Dry fire events are often catastrophic for the bow.
[0006] Many existing lighted nock systems have components that transfer forces to the inside surface of the arrow shaft, causing arrow shaft fractures, such as U.S. Pat. No. 7,021,784 (DiCarlo) and U.S. Pat. No. 9,546,851 (Kim). Some lighted nock systems that rely on nock translation to activate the light also require the entire light assembly to be removed from the arrow to deactivate the light. Most of the lighted nock systems suffer from unintended activation of the light, such as

during transport, which can drain the battery.

SUMMARY

[0007] One embodiment relates to matched arrow set that includes a first arrow and a second arrow. The first arrow including: a first shaft, a first bushing coupled to the first shaft, and a first nock received in the first bushing. The second arrow including: a second shaft, a second bushing coupled to the second shaft, and a second nock received in the second bushing. The first shaft and the first bushing define a first weight, the second shaft and the second bushing define a second weight greater than the first weight, and a first arrow weight is substantially the same as a second arrow weight.

[0008] Another embodiment relates to a matched weight arrow set that includes a first arrow including a lighted nock assembly and defining a first weight, and a second arrow including a non-lighted nock assembly and defining a second weight. The lighted nock assembly weighs more than the non-lighted nock assembly, and the first weight is within two percent of the second weight.

[0009] Another embodiment relates to a matched weight arrow set that includes a first arrow and a second arrow. The first arrow defines a first arrow weight and includes: a first shaft, a first bushing coupled to the first shaft, wherein the first shaft and the first bushing define a first base weight, and a lighted nock received in the first bushing. The lighted nock includes: a head configured to engage a drawstring, a shank formed with the head and sized to be received within the first bushing and defining a cavity, and a light assembly received in the cavity. The second arrow defines a second arrow weight and includes: a second shaft, a second bushing coupled to the second shaft, wherein the second shaft and the second bushing define a second base weight, and a non-lighted nock received in the second bushing. The first arrow weight is within five percent of the second arrow weight, and the first base weight is less than the second base weight.

[0010] This summary is illustrative only and is not intended to be in any way limiting. Other aspects, inventive features, and advantages of the devices or processes described herein will become apparent in the detailed description set forth herein, taken in conjunction with the accompanying figures, wherein like reference numerals refer to like elements.

Description

BRIEF DESCRIPTION OF THE FIGURES

[0011] FIG. **1** is a perspective view of a nock for an archery arrow in accordance with an embodiment of the present disclosure.

[0012] FIG. **2** is a top view of the nock of FIG. **1**.

[0013] FIG. **3** is a side view of the nock of FIG. **1**.

[0014] FIG. **4** is an end view of the nock of FIG. **1**.

[0015] FIG. **5** is an end view of the nock of FIG. **1**.

[0016] FIGS. **6**A and **6**B are sectional views of a lighted nock assembly in accordance with an embodiment of the present disclosure.

[0017] FIGS. **7**A and **7**B are sectional views of a light assembly in accordance with an embodiment of the present disclosure.

[0018] FIG. **7**C is a sectional view of an alternate light assembly with multiple acceleration switches in accordance with an embodiment of the present disclosure.

[0019] FIG. **8**A is a sectional view of a combination lighted nock assembly and bushing in accordance with an embodiment of the present disclosure.

[0020] FIG. **8**B is a perspective view of the bushing of FIG. **8**A.

[0021] FIG. **9** is a sectional view of a lighted nock assembly for a half-moon nock in accordance with an embodiment of the present disclosure.

[0022] FIG. **10** is a sectional view of a lighted nock assembly for a V-nock in accordance with an

embodiment of the present disclosure.
[0023] FIG. **11** is a sectional view of a lighted nock assembly for a flat nock in accordance with an embodiment of the present disclosure.
[0024] FIG. **12**A is a perspective view of an alternate lighted nock assembly used with a bushing in accordance with an embodiment of the present disclosure.
[0025] FIG. **12**B is cross-sectional view of the lighted nock assembly of FIG. **12**A in a deactivated configuration in accordance with an embodiment of the present disclosure.
[0026] FIG. **12**C is cross-sectional view of the lighted nock assembly of FIG. **12**A in an activated configuration in accordance with an embodiment of the present disclosure.
[0027] FIG. **13**A is an exploded view of the lighted nock assembly of FIG. **12**A.
[0028] FIG. **13**B is a sectional view of the lighted nock assembly of FIG. **12**A without the bushing.
[0029] FIGS. **14**A and **14**B illustrate an interface of the bushing and the nock of FIG. **12**A.
[0030] FIG. **15** illustrates the light assembly of FIG. **12**A.
[0031] FIGS. **16**A and **16**B illustrate the battery stop of FIG. **12**A.
[0032] FIGS. **17**A and **17**B illustrate a tab stop for use with a lighted nock assembly in accordance with an embodiment of the present disclosure.
[0033] FIG. **18** illustrates a matched weight arrow that can be used with or without a lighted nock assembly in accordance with an embodiment of the present disclosure.

DETAILED DESCRIPTION

[0034] Following below are more detailed descriptions of various concepts related to, and implementations of, methods, apparatuses, and systems for nocks. Before turning to the figures, which illustrate certain exemplary embodiments in detail, it should be understood that the present disclosure is not limited to the details or methodology set forth in the description or illustrated in the figures. It should also be understood that the terminology used herein is for the purpose of description only and should not be regarded as limiting.
[0035] FIGS. **1** through **5** illustrate various views of an exemplary nock **21** in accordance with an embodiment of the present disclosure. The nock **21** is molded from a reinforced polymeric material (or blend of polymeric materials). The nock **21** can be used with or without a light assembly, as will be discussed herein.
[0036] For lighted nock applications, the reinforced polymeric material is preferably transparent, but may also be semi-transparent or translucent. Light transmittance of the polymeric material is preferably at least 65%, more preferably at least 75%, and most preferably at least 85%. Nocks for vertical bows and crossbows are often distinguished in their general shape, but both are collectively referred to herein as “nocks”. As used herein, the term “bows” refers generically to both vertical bows and crossbows.
[0037] The nock **21** illustrated in FIGS. **1**-**5** is a clip-on nock. The prongs **23** flex outward **25** until the bowstring is seated in semi-circular opening **27**. In order to withstand the forces generated in high-powered bows, the polymeric material must have a high impact strength, but also requires sufficient flexibility to permit the nock prongs **23** to deflect when engaging with and disengaging from the bowstring **29**. The polymeric material preferably has a tensile strength of greater than about 10,000 pounds per square inch (psi) as determined by ASTM D638. The polymeric material preferably has a flexural strength of greater than about 20,000 psi as determined by ASTM D790. The polymeric material preferably has a flexural modulus of greater than 0.50×106 psi. The flexural modules is the ratio, within the elastic limit, of stress corresponding to strain.
[0038] The reinforcing material can be plastic, metal, ceramic, glass, wood, and/or natural and synthetic composite material, and so forth, as well as combinations thereof. For example, reinforcing material can be glass, carbon, titanium, aluminum, stainless steel, talc, mica, quartz, Wollastonite, as well as combinations thereof. The form of the reinforcing material can be fibers (including woven, nonwoven (e.g., felt), chopped, continuous, and/or random fibers), flakes, beads, particles, and combinations thereof. In one embodiment, the reinforcing material has an average

aspect ratio (i.e., the ratio of a structure's size in different dimensions) of at least about 5:1, and more preferably at least about 7:1, and most preferably about 10:1.
[0039] In one embodiment, the nock 21 is molded from a high impact, transparent polycarbonate material filled with between about 10% to about 30% by weight reinforcing material. In one embodiment, the reinforcing material is about 20% by weight glass fibers or filamentous glass. The glass fibers preferably have diameters in the range of about 5 microns to about 100 microns and a length of less than about 2 millimeters. One polymeric material suitable for the present high impact nock is available from RTP Company of Winona, Wis. under the product designation RTP 303. While the material is substantially transparent, it exhibits a slight yellow tint. Polyurethane, polyetherimide, nylon, polyetheretherketone, polyetherketone, and thermoplastic polyimide may also be used. Other polymeric materials suitable for the present nock **21** are disclosed in U.S. Pat. No. 9,434,334 (Marur et al.); U.S. Pat. No. 7,767,738 (Gagger et al.) and U.S. Pat. No. 5,859,119 (Hoefflin), which are hereby incorporated by reference.
[0040] Transparency is the physical property of allowing light to pass through a material without being scattered. Translucency, on the other hand, allows light to pass through, but the photons can be scattered either at interfaces where there is a change in index of refraction or internally. The nock **21** is preferably constructed from a polymeric material that is transparent (or transparent to certain wavelengths of light due to color tinting of the polymer), while the reinforcing material scatters some portion of the light from the light emitting device. Consequently, portions of the nock **21** both transparent and translucent. That is, a portion of the light emitted by the light emitting device is transmitted through the nock **21** and a portion of the light is scattered by the reinforcing material.
[0041] By altering the percentage of reinforcing material in the polymeric material it is possible to engineer the optimum balance of transmitted light (which creates more directional light source that is visible at a greater distance) and scattered light (which creates a hemispheric distribution of light that is visible from more angles). Applicants have identified a reinforcing material content of about 10% to about 30% by weight as providing optimal light distribution for lighted nock applications.
[0042] The nock **21** illustrated in FIGS. **1**-**5** may be used with the crossbows illustrated in U.S. Pat. No. 9,494,379 (Yehle) entitled Crossbow, filed Apr. 14, 2016 and U.S. patent application Ser. No. 15/433,769 entitled Crossbow, filed Feb. 15, 2017, both of which are hereby incorporated by reference. In particular, the anti-dry fire mechanism disclosed in the patents noted above preferably engages with the nock **21** in the region **31** behind the bowstring **29**. The region **31** is preferably at least about 0.1 inches. Flat regions **33** illustrated in FIG. **3** are preferably separate by a distance **35** of about 0.250 inches, which corresponds to a gap between fingers on a bowstring catch for the crossbow in the patents noted above.
[0043] FIGS. **6**A and **6**B are cross-sectional views of the lighted nock assembly **20** in accordance with an embodiment of the present disclosure. In the illustrated embodiment, the light assembly **24** is a “bobber-light” that includes light emitting device **26**, such as a filament light, an LED, or other light producing device, electrically coupled to battery **28**. The nock **21** includes recess **22** configured to receive the light emitting device **26**.
[0044] In the illustrated embodiment, elastomeric member **30** maintains gap **32** between light emitting device **26** and the battery **28** corresponding to the battery **28** being disconnected from the light emitting device **26** (see FIG. **7**A). The light assembly **24** is biased to the deactivated configuration by the elastomeric member **30**.
[0045] As best illustrated in FIG. **6**B, on launch the bowstring (not shown) applies force **34** to displace the nock **21** into the arrow shaft **36**, reducing or closing the gap **38**. Bottom surface **40** of the recess **22** simultaneously displaces the light emitting device **26** toward the battery **28** to complete the circuit and altering the light emitting device to an activated state (see e.g., FIG. **7**B). Elastomeric insert **46** secures the battery **28** to the inside surface **44** of the arrow shaft **36** so as to create force **48** that opposes the force **34** applied to the light emitting device **26** by displacement of

the nock **21**. The opposing forces **34** and **48** compress the elastomeric material **30** and substantially closes the gap **32**, resulting in the battery **28** being electrically coupled to the light emitting device **26** (see FIG. **7**B). The light emitting device **26** is now in the activated state.

[0046] The light assembly **24** is moved to the deactivated configuration by pulling the nock **21** slightly out of the arrow shaft **36** as illustrated in FIG. **6**A and reestablishing the gap **38**. The elastomeric material **30** simultaneously displaces the light emitting device **26** away from the battery **28** and opens the circuit to deactivate the light emitting device **26** (see e.g., FIG. **7**A). The light assembly **24** is normally biased to the deactivated configuration absent an external force.

[0047] FIGS. **7**A and **7**B illustrate the light assembly **24** in accordance with an embodiment of the present disclosure. FIG. **7**A illustrates the light assembly **24** in the deactivated configuration and FIG. **7**B illustrates the activated configuration. The light emitting device **26** includes a pair of electrical contacts **50** and **52** that extend rearward within housing **54** toward the battery **28**. In the illustrated embodiment the contact **50** is engaged with one pole of the battery **28** at all times. In the deactivated configuration the contact **52** is separated from the other pole **56** of the battery **28**. The elastomeric member **30** maintains that separation. In another embodiment, a metal spring may be located generally concentrically around the pole **56** to serve as both the contact **50** and to provide the biasing force of the elastomeric member **30**. In both embodiments the light assembly **24** is biased to the inactive configuration.

[0048] As illustrated in FIG. **7**B, when the light assembly **24** is subject to a longitudinal compressive force **58** the elastomeric member **30** is elastically deformed and compressed a sufficient amount so the contact **52** engages with the other pole **56** of the battery **28**, completing the circuit so the light emitting device **26** is in the activated state. When the longitudinal compressive force **58** is removed the elastomeric member **30** automatically returns to its original size and shape (see FIG. **7**A), which displaces the contact **52** way from the pole **56** of the battery **28** to move the light emitting device **26** to the deactivated state.

[0049] In another embodiment, the light emitting device **26** is secured in the recess **22** in the nock **21**. When the nock **21** is pulled away from the arrow shaft **36** and the gap **38** is reset, the light emitting device **26** and the contact **52** are also displaced away from the pole **56** of the battery **28** and the light emitting device **26** is in the deactivated state. The elastomeric member **30** is not required in this embodiment.

[0050] In an alternate embodiment illustrated in FIG. **7**C, one or more accelerometer switches or an integrated circuit accelerometer **100**A, **100**B ("**100**") control activation of the light emitting device **26**, such as disclosed in U.S. Pat. No. 7,993,224 (Brywig), which is hereby incorporated by reference. The switches **100** respond to the forces resulting from the acceleration of the arrow upon release or deceleration of the arrow upon impact with a target. In one embodiment, multiple accelerometer switches **100** are provided to sense acceleration and/or deceleration along multiple axes **102**, **104**. For example, axis **102** may be located along a longitudinal axis of the arrow and the axis **104** is perpendicular to the axis **102**. Triggering of the light emitting device **26** preferably requires a combination of acceleration and/or deceleration signals along the two different axes **102**, **104**.

[0051] FIGS. **8**A and **8**B illustrate an alternate lighted nock assembly **20** used in combination with bushing **60** in accordance with an embodiment of the present disclosure. The bushing **60** is a hollow cylinder that is interposed between the nock **21** and the arrow shaft **36** to reinforce the shaft **36**. The light assembly **24** extends through center opening **62** in the bushing **60**. The bushing **60** is preferably aluminum or other light-weight metal.

[0052] The present disclosure is not limited to the light assemblies **24** illustrated herein. The present lighted nock assembly **20** can be modified to operate with a variety of light assemblies, including without limitation the light assemblies disclosed in U.S. Pat. No. 4,340,930 (Carissimi), U.S. Pat. No. 4,547,837 (Bennett); U.S. Pat. No. 5,134,552 (Call et al.); U.S. Pat. No. 6,123,631 (Ginder); U.S. Pat. No. 6,736,742 (Price et al.); U.S. Pat. No. 7,021,784 (DiCarlo); U.S. Pat. No.

7,211,011 (Sutherland); U.S. Pat. No. 7,837,580 (Huang); U.S. Pat. No. 7,931,550 (Lynch); U.S. Pat. No. 7,927,240 (Lynch); U.S. Pat. No. 7,993,224 (Brywig); U.S. Pat. No. 8,342,990 (Price); U.S. Pat. No. 8,540,594 (Chu); U.S. Pat. No. 8,758,177 (Minica); U.S. Pat. No. 8,777,786 (Bay); U.S. Pat. No. 8,944,944 (Pedersen et al.); U.S. Pat. No. 9,140,527 (Pedersen et al.); U.S. Pat. No. 9,151,580 (Pedersen); U.S. Pat. No. 9,243,875 (Minica); U.S. Pat. No. 9,279,647 (Marshall); U.S. Pat. No. 9,279,648 (Marshall); U.S. Pat. No. 9,279,649 (Bay); U.S. Pat. No. 9,404,720 (Pedersen); U.S. Pat. No. 9,423,219 (Pedersen et al.); U.S. Pat. No. 9,518,806 (Pedersen); U.S. Pat. No. 9,546,851 (Kim); 2015/0192395 (Beck), which are hereby incorporated by reference.

[0053] The present disclosure is applicable to any nock configuration, including without limitation, flat, half-moon, slotted, and universal nocks, such as disclosed in U.S. Pat. No. 9,441,925 (Palomaki et al.); U.S. Pat. No. 9,285,195 (Palomaki et al.); U.S. Pat. No. 9,212,874 (Harding); U.S. Pat. No. 8,622,855 (Bednar et al.); U.S. Pat. No. 7,189,170 (Korsa et al.); U.S. Pat. No. 5,803,843 (Anderson et al.); D717,389 (Huang); D664,625 (Minica); D641,827 (Errett); and D595,803 (Giles), which are hereby incorporated by reference.

[0054] FIG. **9** illustrates a lighted nock assembly **70** including a light assembly **24** and a half-moon nock **72** in accordance with an embodiment of the present disclosure. FIG. **10** illustrates a lighted nock assembly **80** including a light assembly **24** and a V-nock **82** in accordance with an embodiment of the present disclosure. FIG. **11** illustrates a lighted nock assembly **90** including a light assembly **24** and a flat nock **92** in accordance with an embodiment of the present disclosure.

[0055] FIGS. **12**A through **12**C illustrate an alternate lighted nock assembly **120** used in combination with bushing **122** in accordance with an embodiment of the present disclosure. The bushing **122** is preferably constructed from a light weight metal and is sized to be receive within arrow shaft **142**. In the illustrated embodiment, the bushing **122** includes shoulder **123** that engages with rear end **125** of the arrow shaft **142**.

[0056] In the illustrated embodiment, the light assembly **124** is a “bobber-light” that includes light emitting device **126**, such as a filament light, an LED, or other light producing device, electrically coupled to battery **128**. See also, FIG. **15**. The light emitting device **126** is mechanically coupled to a battery **128**. Displacing the light emitting device **126** toward the battery **128** activates the light emitting device **126** and displacing the light emitting device **126** away from the battery **128** deactivates the light emitting device. FIG. **12**B illustrates the lighted nock assembly **120** in a deactivated configuration **110** and FIG. **12**C illustrates the lighted nock assembly **120** in an activated configuration **112**, as will be discussed further herein.

[0057] As best illustrated in FIG. **12**B, the nock **130** includes recess **132** configured to receive the light assembly **124** (see also FIG. **14**A). The light emitting device **126** is secured in the recess **132** using a variety of means, such as fasteners, adhesives, inter-locking structures, and the like. Only the light emitting device **126** is attached to the nock **130** so the remainder of the light assembly **124** can move relative to the nock, as illustrated in FIG. **12**C. The nock **130** is preferably molded from a transparent, high impact strength polymeric material, as discussed herein.

[0058] Battery **128** is secured to inside surface **138** of the bushing **122** by battery stop **136**. The battery stop **136** is attached to the battery **128** at a location offset from the nock **130**, even in the activated configuration **112**. The battery stop **136** is a discrete component from the nock **130** and the bushing **122**. Consequently, the nock **130** is coupled to the battery stop **136** by the battery **128**, such that movement of the nock **130** relative to the bushing **122** is independent from the engagement of the battery stop **136** with the bushing **122**.

[0059] Distal end **127** of the bushing **122** preferably includes a structure **129**, such as a ridge or a shoulder that limits displacement of the battery stop **136** in direction **131**. The tolerances on the battery stop **136** are such that it can slide within the bushing **122**, but substantially limits radial displacement of the battery **128** within the arrow shaft **142**. This configuration also serves to reinforce the nock **130** from torque applied by a bowstring. These forces are substantially contained within the bushing **122**, rather than the arrow shaft **142**.

[0060] In the illustrated embodiment, the battery **128** is glued to center opening **148** that extends through the battery stop **136**. The center opening **148** permits the battery stop **136** to be slid along the battery **128** to the optimum location before being glued in place. It is also possible to use a longer battery **128** that extends past distal end of the battery stop **136**.
[0061] Friction member **134**, such as an elastomeric O-ring, is located in recess **135** in the battery stop **136**. See also, FIGS. **16**A and **16**B. The friction member **134** engages with inside surface **138** of the bushing **122** rather than inside surface **140** of the arrow shaft **142**. In the illustrated embodiment, inside surface **138** of the bushing **122** includes recess **144** that receives a portion of the friction member **134**. Locating the O-ring **134** in the opposing recesses **135**, **144** resists longitudinal displacement of the battery **128** in the bushing **122** a sufficient amount to permit the nock **130** to be pulled to reset the gap **152** to the deactivated configuration **110**, without removing the lighted nock assembly **120** from the bushing **122** (see FIG. **12**C). By applying additional pulling force to the nock **130**, the entire lighted nock assembly **120** (light assembly **124**, battery stop **136**, and nock **130**) can be removed from the bushing **122** and replaced.
[0062] Because the lighted nock assembly **120** is contained within the bushing **122**, forces applied to the nock **130** during launch are transmitted to the shaft **142** through the bushing **122**. For example, radial outward forces **146** transmitted to the battery stop **136** and friction member **134** are contained by the bushing **122**, rather than the arrow shaft **142**. Many existing lighted nock systems have components that transfer forces to the inside surface of the arrow shaft, causing arrow shaft fractures. The present system isolates the forces generated by the nock **130** within the bushing **122**, so any forces experience by the nock **130** are transmitted to the arrow shalt **142** by the bushing **122**, greatly extending arrow life. When combined with a nock molded from a transparent, high impact strength polymeric material, the present lighted nock assembly **120** is suitable for use with high-powered bows and crossbows.
[0063] On launch the bowstring (not shown) applies force **150** that displaces the nock **130** into the arrow shaft **142** to the activated configuration **112** shown in FIG. **12**C, reducing or closing the gap **152**. Bottom surface **154** of the recess **132** simultaneously displaces the light emitting device **126** toward the battery **128**, completing the circuit and placing the light emitting device **126** to an activated state. The friction member **134** secures the battery **128** to the inside surface **138** of the bushing **122** so as to create force **156** that opposes the force **150** applied to the light emitting device **126** by displacement of the nock **130**. The opposing forces **150** and **156** displace the light emitting device **126** toward the battery **128** to substantially reduce or close the gap **158** and to activate the light emitting device **126**.
[0064] The light assembly **124** is moved to the deactivated configuration **110** by pulling the nock **130** slightly out of the arrow shaft **142** to reestablish the gap **152**, as illustrated in FIG. **12**B. The friction member **134** secures the battery stop **136** that is attached to the battery **128** within the bushing **122** in opposition to the nock **130** being pulled away from the bushing **122**. Consequently, the light emitting device **126** can be deactivated without removing the light assembly **124** from the bushing **122**.
[0065] FIGS. **13**A and **13**B show the lighted nock assembly **120** separated from the bushing **122**. Since the battery stop **136** is glued to the battery **128** and the LED **126** is glued to the nock **130**, the entire lighted nock assembly **120** can be removed from the bushing **122**. In the event the light assembly **124** is not working or the nock **130** damaged, the user can pull the entire lighted nock assembly **120** from the bushing **122** by overcoming the frictional coupling generated by the friction member **134** engaged with the recess **144** (see FIG. **12**B) in the bushing **122**. A replacement lighted nock assembly **120** is then re-inserted into the bushing **122**. This configuration permits the bushing **122** to be permanently attached, such as with an adhesive, to the arrow shaft **142** (see FIG. **12**B).
[0066] The nock **130** preferably includes one or more ridges **160** that mate with corresponding grooves **162** located on inside surface **138** in center opening **164** of the bushing **122**. The ridges **160** and grooves **162** prevent the nock **130** from rotating axially relative to the bushing **122** so the

nock opening **166** is retained in the correct orientation relative to the arrow shaft **142**. See also, FIGS. **14**A and **14**B.

[0067] FIGS. **17**A and **17**B illustrate the lighted nock assembly **120** and the bushing **122** with stop tab **170** located in the gap **152** (see FIG. **12**A) to prevent inadvertent activation of the light assembly **124**. The tab stop **170** is useful for shipping purposes and for carrying arrows containing the present lighted nock assembly **120** in the field. The stop tab **170** includes one or more arms **172** that wrap around the stem of the nock **130** and block the gap **152** from closing. The arms **172** are designed to flex outward during insertion into, and removal from, the gap **152**.

[0068] In the illustrated embodiment, the tab stop **170** includes a handle portion **174** that is large enough to prevent the nock **130** from being engaged with a crossbow trigger housing, forcing the user to remove the tab stop **170** before nocking the arrow. The handle portion **174** preferably has at least one major dimension **176** that is at least about two times an outside diameter **180** of the arrow shaft **142** (see FIG. **12**B) coupled to the nock **130**, and more preferably at least about three times the outside diameter of the arrow shaft.

[0069] FIG. **18** illustrates a matched weight arrow **190** that can be both lighted and non-lighted, in accordance with an embodiment of the present disclosure. As used herein, “matched weight arrows” refers to a plurality of arrows with the same functional characteristics, such as for example, length, stiffness, weight, and diameter, that exhibit substantially similar flight characteristics when launched from the same bow. The present matched weight arrows **190** have a weight difference of less than about 10%, more preferably less than about 5%, and most preferably less than about 2%. In operation, matched weight arrows can be used interchangeable without adjusting the sight or scope on the bow.

[0070] The arrow **190** includes a threaded front insert **192** that receives an arrow head (not shown), a shaft **194**, fletching **196**, and a rear opening **198** configured to receive any of the bushings and/or nocks disclosed herein. The present matched weight arrow **190** is configured to have substantially the same weight, whether used with our without the present lighted nock assembly **120**, so their flight characteristics are the substantially the same. Consequently, a user can select either a lighted arrow or a non-lighted arrow without having to compensate for different weight arrows.

[0071] For a non-lighted arrow **190**, for example, the bushing **60** (see FIG. **8**B) and the nock **21** (FIG. **1**) are inserted into the rear opening **198**, without the lighted nock assembly **120**.

[0072] For a lighted arrow **190**, for example, the present lighted nock assembly **120** and bushing **122** is inserted into the rear opening **198**. Since the lighted nock assembly **120** and bushing **122** are heavier than just the nock **21** and bushing **60**, weight is preferably removed elsewhere from the lighted arrow, such as from the shaft **194**, the threaded front insert **192**, or the fletching **196**, so the lighted arrow weighs substantially the same as a non-lighted arrow. In one embodiment, weight is removed from the front insert **192** of the lighted arrow to offset the weight added by the lighted nock assembly **120**. In one embodiment, the rear bushing **122** used with the lighted arrow assembly **120** is lighter than the bushing **60**, to offset some or all of the weight difference. In another embodiment, weight is added to the non-lighted arrows, such for example, in the threaded front insert **192** or the rear bushing **60**, equal to the amount of weight added by the lighted nock assembly **120** and bushing **122**. Consequently, the user can carry both lighted arrows and non-lighted arrows having substantially the same weight and flight characteristics. These matched weight arrows **190** can be used interchangeable without effecting accuracy.

[0073] Where a range of values is provided, it is understood that each intervening value, to the tenth of the unit of the lower limit unless the context clearly dictates otherwise, between the upper and lower limit of that range and any other stated or intervening value in that stated range is encompassed within this disclosure. The upper and lower limits of these smaller ranges which may independently be included in the smaller ranges is also encompassed within the disclosure, subject to any specifically excluded limit in the stated range. Where the stated range includes one or both of the limits, ranges excluding either both of those included limits are also included in the

disclosure.
[0074] Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this disclosure belongs. Although any methods and materials similar or equivalent to those described herein can also be used in the practice or testing of the various methods and materials are now described. All patents and publications mentioned herein, including those cited in the Background of the application, are hereby incorporated by reference to disclose and described the methods and/or materials in connection with which the publications are cited.
[0075] The publications discussed herein are provided solely for their disclosure prior to the filing date of the present application. Nothing herein is to be construed as an admission that the present disclosure is not entitled to antedate such publication by virtue of prior invention. Further, the dates of publication provided may be different from the actual publication dates which may need to be independently confirmed.
[0076] Other embodiments are possible. Although the description above contains much specificity, these should not be construed as limiting the scope of the disclosure, but as merely providing illustrations of some of the presently preferred embodiments. It is also contemplated that various combinations or sub-combinations of the specific features and aspects of the embodiments may be made and still fall within the scope of this disclosure. It should be understood that various features and aspects of the disclosed embodiments can be combined with or substituted for one another in order to form varying modes disclosed. Thus, it is intended that the scope of at least some of the present disclosure should not be limited by the particular disclosed embodiments described above.
[0077] Thus the scope of this disclosure should be determined by the appended claims and their legal equivalents. Therefore, it will be appreciated that the scope of the present disclosure fully encompasses other embodiments which may become obvious to those skilled in the art, and that the scope of the present disclosure is accordingly to be limited by nothing other than the appended claims, in which reference to an element in the singular is not intended to mean “one and only one” unless explicitly so stated, but rather “one or more.” All structural, chemical, and functional equivalents to the elements of the above-described preferred embodiment that are known to those of ordinary skill in the art are expressly incorporated herein by reference and are intended to be encompassed by the present claims. Moreover, it is not necessary for a device or method to address each and every problem sought to be solved by the present disclosure, for it to be encompassed by the present claims. Furthermore, no element, component, or method step in the present disclosure is intended to be dedicated to the public regardless of whether the element, component, or method step is explicitly recited in the claims.

Claims

1-**20**. (canceled)
21. A matched arrow set, comprising: a first arrow including: a first shaft; a first bushing coupled to the first shaft; and a first nock received in the first bushing, the first nock comprising a light assembly; and a second arrow including: a second shaft; a second bushing coupled to the second shaft; and a second nock received in the second bushing, the second nock excluding a light assembly; wherein a weight of the first arrow is substantially the same as a weight of the second arrow.
22. The matched arrow set of claim 21, wherein the light assembly is configured to selectively alter between a non-lighted state before an arrow is fired to a lighted state after the arrow is fired.
23. The matched arrow set of claim 21, wherein the first nock is a lighted nock, and the first nock includes: a head configured to engage a drawstring; a shank formed with the head, the shank configured to be received within the first bushing and defining a cavity; and the light assembly received in the cavity.

24. The matched arrow set of claim 21, wherein the first nock is a lighted nock, and the lighted nock moves within the first bushing between an activated position and a deactivated position.
25. The matched arrow set of claim 21, wherein the first arrow defines substantially the same length as the second arrow.
26. The matched arrow set of claim 21, wherein a weight of the first bushing is less than a weight of the second bushing.
27. The matched arrow set of claim 21, wherein a weight of the first shaft is less than a weight of the second shaft.
28. A matched weight arrow set, comprising: a first arrow including a lighted nock assembly and defining a first weight, the lighted nock assembly including a light assembly; and a second arrow including a non-lighted nock assembly and defining a second weight, the non-lighted nock assembly excluding a light assembly, wherein the first weight is within two percent of the second weight.
29. The matched weight arrow set of claim 28, wherein the first arrow includes a first front insert, and wherein the second arrow includes a second front insert weighing more than the first front insert.
30. The matched weight arrow set of claim 28, wherein the first arrow includes a first bushing sized to receive the lighted nock assembly, and wherein the second arrow includes a second bushing sized to receive the non-lighted nock assembly and weighing more than the first bushing.
31. The matched weight arrow set of claim 28, wherein the first arrow includes a first shaft, and wherein the second arrow includes a second shaft weighing more than the first shaft.
32. The matched weight arrow set of claim 28, wherein the light assembly includes a light emitting device and a battery, and wherein the light emitting device transitions from a deactivated state before the first arrow is fired to an activated state after the first arrow is fired.
33. The matched weight arrow set of claim 28, wherein the first arrow includes a bushing, wherein the lighted nock assembly includes: a head configured to engage a drawstring; a shank formed with the head and sized to be received within the bushing and defining a cavity; and the light assembly received in the cavity; and wherein the lighted nock assembly moves linearly within the bushing between an activated position and a deactivated position.
34. The matched weight arrow set of claim 28, wherein the first arrow defines substantially the same length as the second arrow.
35. A matched weight arrow set, comprising: a first arrow defining a first arrow weight and including: a first shaft; a first bushing coupled to the first shaft; and a lighted nock received in the first bushing and including: a head configured to engage a drawstring; a shank formed with the head and sized to be received within the first bushing and defining a cavity; and a light assembly received in the cavity; and a second arrow defining a second arrow weight and including: a second shaft; a second bushing coupled to the second shaft; and a non-lighted nock received in the second bushing, the non-lighted nock excluding a light assembly; wherein the first arrow weight is within five percent of the second arrow weight.
36. The matched weight arrow set of claim 35, wherein: the lighted nock defines a lighted nock weight; the non-lighted nock defines a non-lighted nock weight; a nock difference weight is defined by the lighted nock weight minus the non-lighted nock weight; the first shaft and the first bushing define a first base weight; the second shaft and the second bushing define a second base weight; and the first base weight is less than the second base weight by the nock difference weight.
37. The matched weight arrow set of claim 35, wherein the first arrow defines substantially the same length as the second arrow.
38. The matched weight arrow set of claim 35, wherein a weight of the first bushing is less than a weight of the second bushing.
39. The matched weight arrow set of claim 35, wherein a weight of the first shaft is less than a weight of the second shaft.

40. The matched weight arrow set of claim 35, further comprising: a battery stop at least partially disposed within the first bushing and coupled to a portion of the light assembly, the battery stop including a first recess; wherein a frictional member at least partially resides within the first recess and a second recess defined by the first bushing.