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(54) CROSSBOW TRIGGER WITH IMPROVED SEAR SURFACE AND ADJUSTMENT WITH ABILITY TO CONTROL TRIGGER PULL WEIGHT WITH VARIOUS INPUT DRAW WEIGHTS

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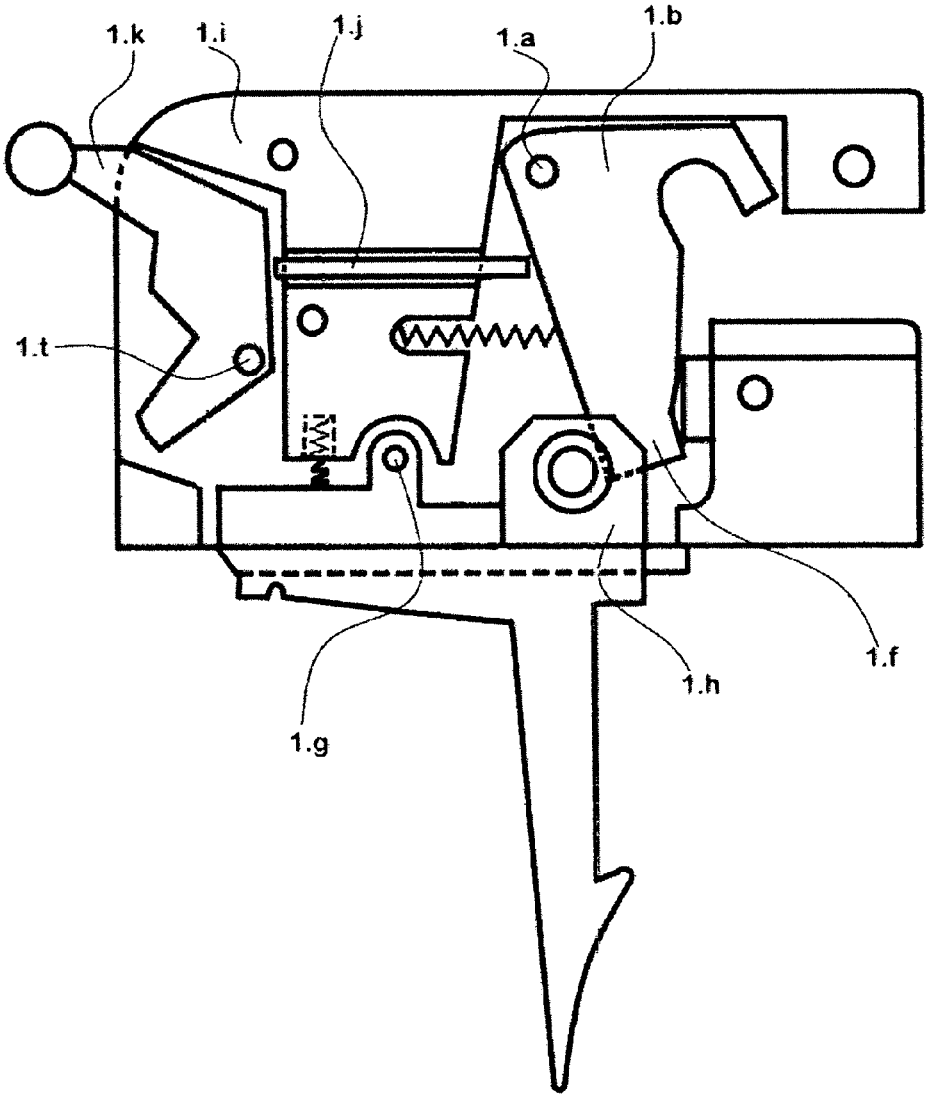
(57) **ABSTRACT**

A crossbow trigger assembly with improved sear surface and reduced friction sear-engaging system. The trigger pull force can be adjusted through the use of a spring pocket that has a threaded insert in it allowing varying tension adjustment. An auto-safety feature consists of a pin that is forced rearward when trigger assembly is cocked, pushing the safety latch to the safe position.



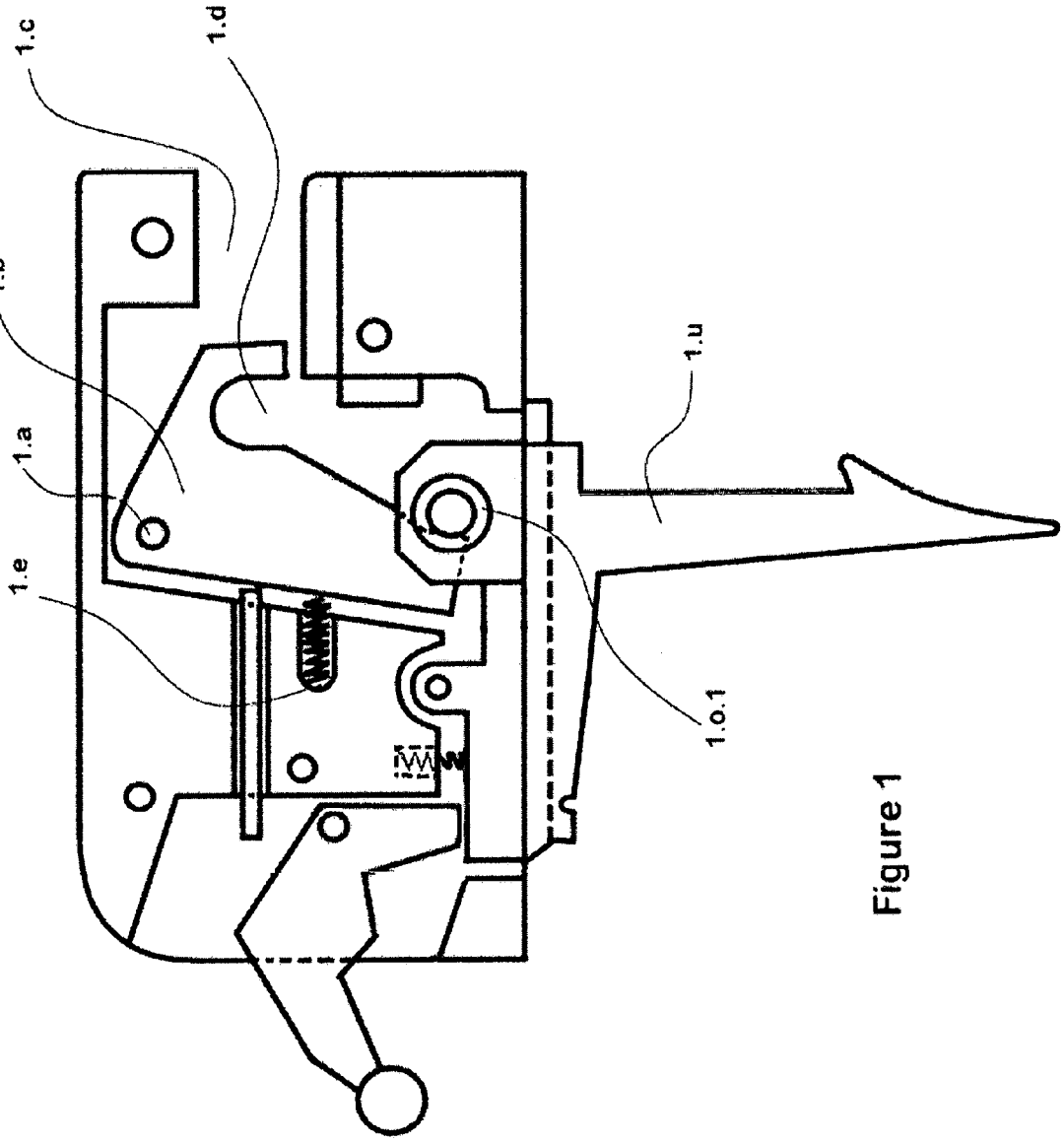


Figure 1

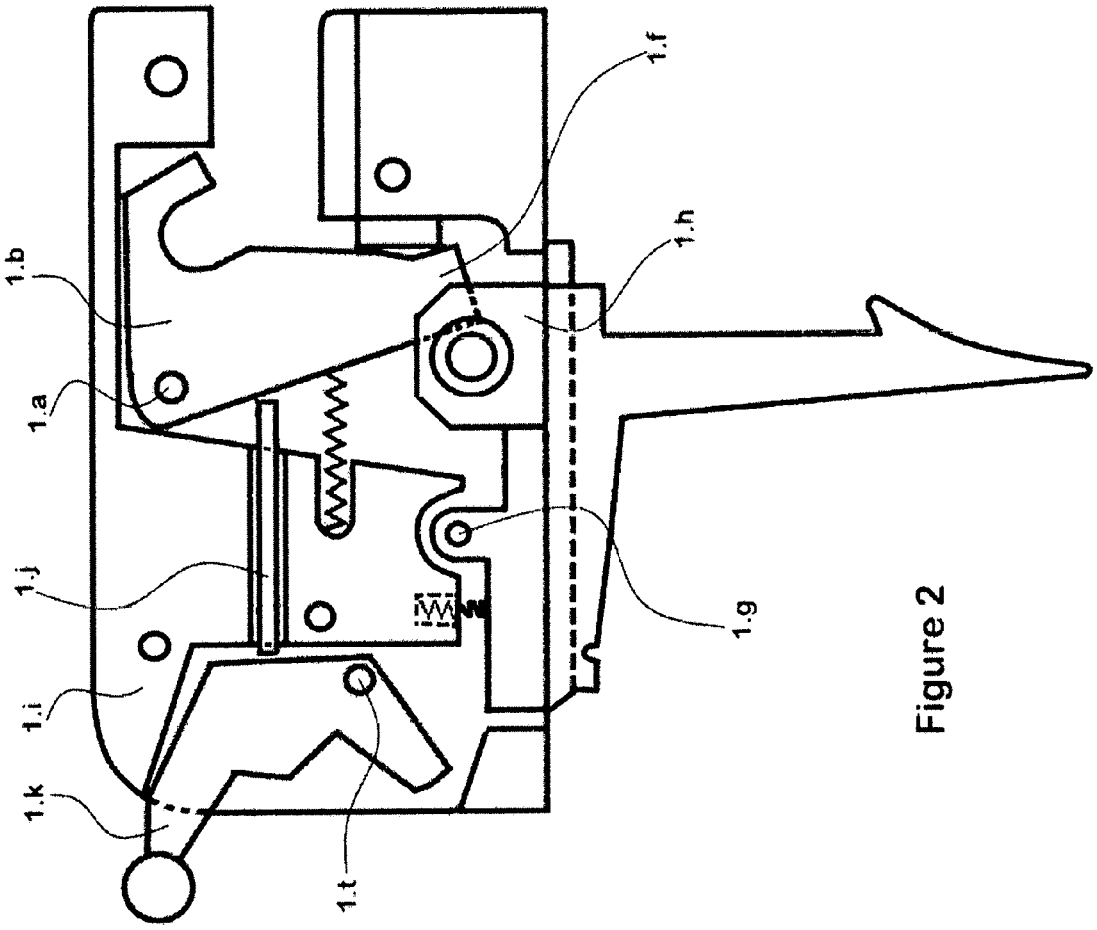


Figure 2

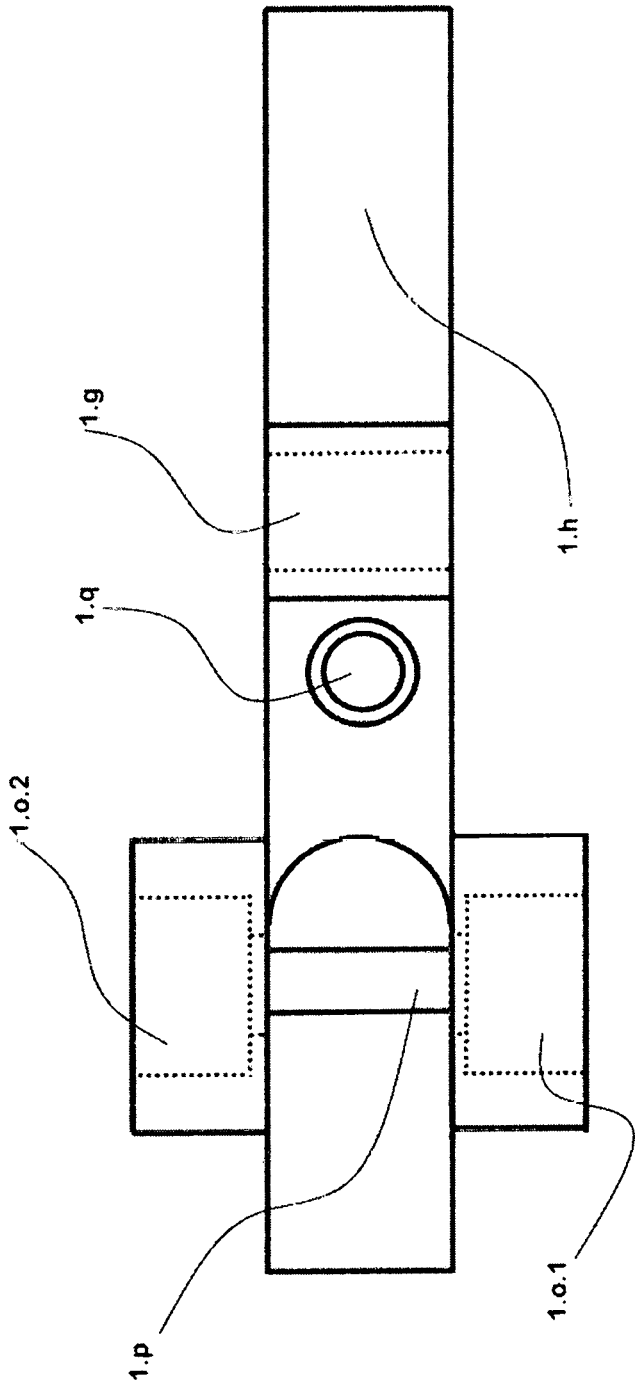


Figure 3.a

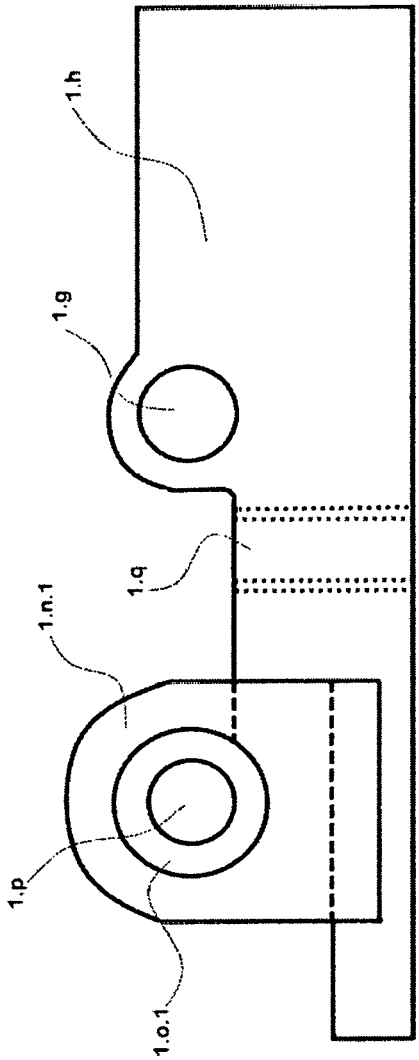


Figure 3.b

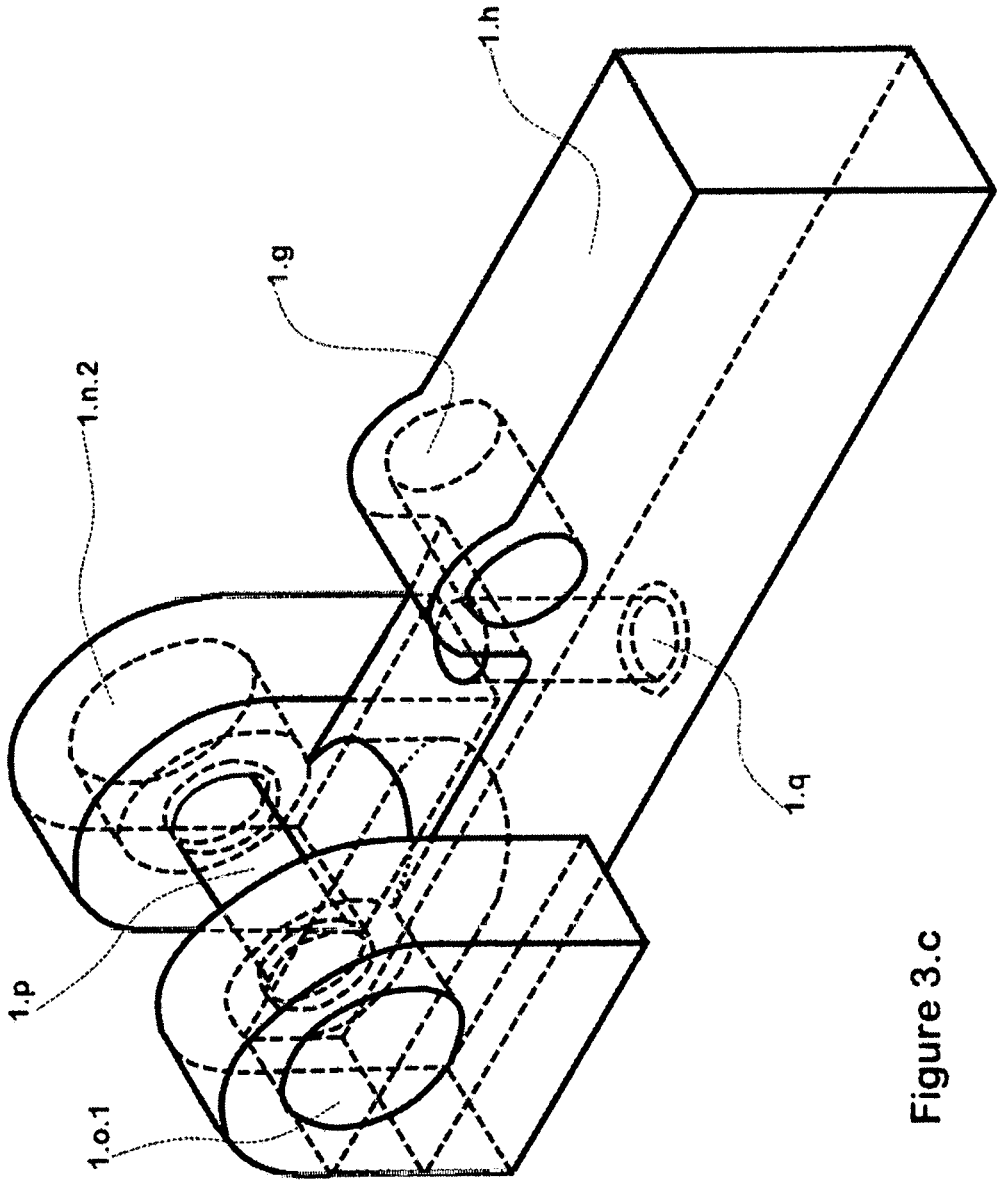


Figure 3.c

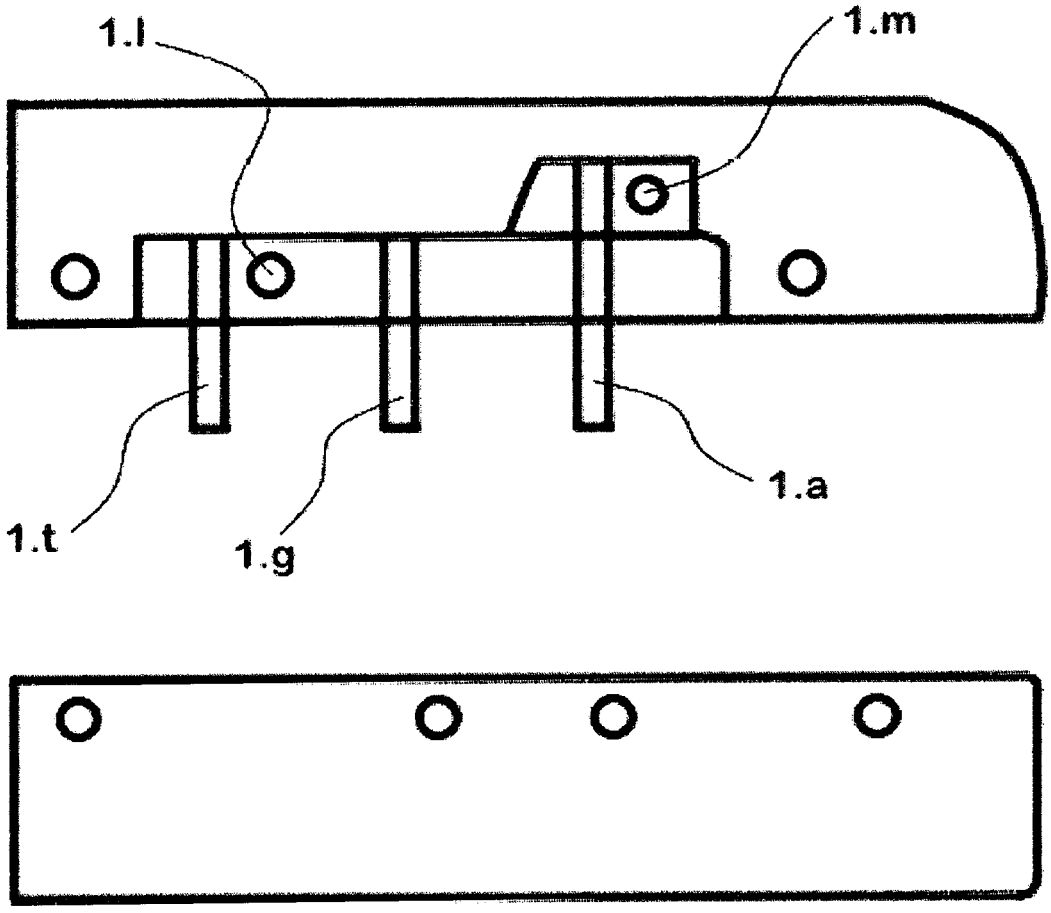


Figure 4

CROSSBOW TRIGGER WITH IMPROVED SEAR SURFACE AND ADJUSTMENT WITH ABILITY TO CONTROL TRIGGER PULL WEIGHT WITH VARIOUS INPUT DRAW WEIGHTS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of Provisional Patent Application No. 61/855,605 filed May 20, 2013 by Derrick J. Middleton and titled "Crossbow trigger with improved sear surface and adjustment with ability to control trigger pull weight with various input draw weights".

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates generally to trigger mechanisms, and more specifically, to a trigger device for a crossbow.

[0004] 2. Description of the Related Art

[0005] Crossbows have long been known in the archery field for use in hunting game. Crossbows have higher draw weights than conventional archery bows and fire arrows (or "bolts") with greater speeds. It is a function of a crossbow to have a lock or trigger mechanism that is able to hold the crossbow string in the ready to fire position once the string is drawn.

[0006] When crossbows are configured for firing, the force exerted by the retracted bowstring can be in the range of approximately 100 to 400 pounds. The trigger assembly of the crossbow must be capable of holding the bowstring in firing position, while allowing the bowstring to be released as the user pulls the trigger. This often results in an excessive pull force which the user must exert upon the trigger of the crossbow to fire the arrow, which in turn decreases the accuracy of the shot.

[0007] Typical trigger mechanisms known in the art use a metal to metal sear mechanism which, during shooting, relies upon one flat metal surface sliding across another flat metal surface, until their engagement breaks off. In view of the substantial pressure exerted between these two flat engaged surfaces, the mating parts need be made of hardened steel to prevent rapid wear; in some cases, wear remains a problem, causing inconsistent trigger pressure and possible misfires. Furthermore, many earlier devices lacked sufficient structure to provide positive, reliable safety means when handling the loaded crossbow.

[0008] A common configuration known in the art comprise trigger assemblies that use upward-opening claws (string retaining members) that hold the string once engaged, as seen for example in U.S. Pat. No. 4,877,008 (to inventor Troubridge), in which two flat metal engaging surfaces (sears) slide off each other upon the activation or depression of a trigger arm, releasing the upward-opening claw and firing the arrow.

[0009] One other commonly used trigger assembly utilizes a downward-opening claw (string-retaining member); as exemplified by U.S. Pat. No. 4,192,281 (to inventor King). In this system, the claw folds down below the string (thus releasing the string) when the trigger is activated; typically, "metal sliding on metal" is the method by which the two flat metal engaging surfaces (sears) disengage.

[0010] In both of the above trigger actions (and, generally, in all trigger systems), trigger pull weight is the weight (or, more exactly the horizontal force, expressed in lbs. force) required to physically depress the trigger and get the string to release. It is a function of these prior art crossbow actions that the trigger pull weight is affected by the draw weight of the bow; for example, a 300 lbs. draw weight bow may require 4 lbs of trigger pull weight to get the string to release; with a 150 lbs draw weight bow, the same action would require less trigger pull weight (possibly 2 lbs) to get the bow to release the same.

[0011] In the case of the two types of prior art trigger systems discussed above, the manufacturers have tried to improve (reduce) trigger draw weight by polishing the engaging surfaces (or sear surfaces) for smoother release. In some other cases, manufacturers reduced trigger draw weight by reducing the overlap of the sear surfaces, which in turn causes an unsafe situation, because a heavier trigger and a heavier draw weight is utilizing less engagement area on the sears to achieve an acceptable trigger pull. It should be understood that these sear surfaces are prone to abrasive wear from the fact they engage each other frictionally with significant weight.

[0012] One other trigger mechanism known in the art, as exemplified by U.S. Pat. No. 4,693,228 (to inventors Simonds et al.) also uses a downward opening claw, but one of the sear surfaces is replaced with a rotating member (a wheel), which engages a slightly curved second sear surface. While one would expect that a wheel would afford reduced friction, thus causing a reduced trigger pull, the Simonds trigger mechanism still exhibits a heavier trigger pull when paired with heavier input draw weights.

[0013] When studying the Simonds trigger, it was realized that its design is less efficient, despite the use of rotating means (wheel) to overcome friction between the two sear surfaces. Because of its structural and functional design, the Simonds trigger has three points of contact (engagement under force) compared to two such points in the Troubridge and. King patents discussed above. The three points of contact in the Simonds trigger assembly are: the trigger sear, the latch wheel sear surface, and the pin surface around which the wheel rotates. Friction, as we know, is the force that resists relative motion between two bodies in contact. Rolling friction occurs when two objects move relative to each other and one rolls on the other (like a car's wheel would roll on the ground). This is classified under static friction because the patch of tire in contact with the ground, at any point while the tire spins, is stationary relative to the ground.

[0014] There is a need in the market, and a sought-after feature by crossbow manufacturers, to have a trigger system that can be utilized on many products with different draw weights, without the need for reconfiguring of the internal levers, toggles and such, that would allow the trigger pull weight to be kept relatively constant, even when paired with crossbows with different input string weights. The above is important because changing movement internally affects the function and engagement of various safety features that need certain clearances and would also need to be altered based on any changed geometry.

[0015] It would be a further desirable feature to have a trigger that retains a relatively constant trigger pull distance, while keeping the trigger pull weight to a comfortable level, while also being easily to maintain.

[0016] It would be a further desirable feature to have a trigger with an auto-safety feature, whereby the safety latch would be automatically placed in the safe position when the trigger assembly is cocked, blocking the possibility of trigger actuation without a further positive action by the user to switch the safety latch out of the safe position.

[0017] Lastly, there is a need in the market for a trigger assembly that uses a rolling sear surface and two immediate points of contact, to truly achieve a reduction in friction when two sear surfaces are engaged under force.

SUMMARY OF THE INVENTION

[0018] It is an object of the present invention to overcome the shortcomings of the prior art, as described above. The present invention use a truly reduced friction sear engaging system, a rolling sear surface and two immediate points of contact, to achieve and maintain a well-controlled and relatively constant trigger pull weight with various input bow draw weights. The improved crossbow trigger of this invention also allows varying input weights (bow draw weights) without changing the geometric function of the trigger assembly components.

[0019] It is a further object of this invention to allow manufacturers (and possibly users) a degree of adjustability of the trigger pull or draw weight, by the use of an internal spring adjustment mechanism. Another object of this invention is a trigger that is able to achieve mechanical advantage of internal components without the use of excessively long lever arms that often result in undesirable long trigger pull distance, commonly referred to as "trigger travel".

[0020] The present invention uses a metal to metal sear mechanism, in which one sear is implemented as a rolling sear surface, namely a dowel mounted on outward roller bearings, to reduce friction and maintain optimal sear engagement at all times.

[0021] It is a further object of this invention to implement an auto-safety feature, whereby the safety latch is automatically placed in the safe position when the trigger assembly is cocked, blocking the possibility of trigger actuation without a further positive action by the user to switch the safety latch out of the safe position.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] FIG. **1** is a frontal view of a preferred embodiment of the present invention, in its locked position, ready for discharge, with half (front) of the housing removed to show the internal components;

[0023] FIG. **2** is a frontal view of a preferred embodiment of the present invention, in its after-fired position, with half (front) of the housing removed to show the internal components;

[0024] FIG. **3***a* is a top view of the lower sear of a preferred embodiment the present invention;

[0025] FIG. **3***b* is a frontal view of the lower sear of a preferred embodiment the present invention;

[0026] FIG. **3***b* is a perspective view of the lower sear of a preferred embodiment the present invention;

[0027] FIG. **4** is a top view of the two halves of the housing of a preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0028] Referring now to the invention in more detail, in FIG. **1** is a crossbow trigger assembly of a preferred embodiment. FIG. **1** shows the trigger in its locked position which would have a string in the string retaining area **1***.d*, ready for discharge. FIG. **2** is the same mechanism in the after-fired position. In FIG. **1**, components are housed in housing **1***.i*., which is machined with cavity areas or pockets to accept the internal components of the system. The claw **1***.b* pivots around the claw pivot point **1***.a*; the claw **1***.b* must pivot upwardly in order to fire. The housing **1***.i* includes an opening **1***.c*. in which the string enters, while an area **1***.d*. is where the string is retained on the back side of the downwardly facing claw **1***.b*. The housing **1***.i* further includes an area **1***.e*. for receiving a spring which would bias the claw into an upward position, should it not have the string to force it to do the same. On the lower portion of the claw member **1***.b* is the upper sear surface **1***.f* for the primary engagement of the input claw weight to the rest of the system. Further lower in housing **1***.i* is the lower sear pivoting point **1***.g*, around which lower sear **1***.h* pivots. The housing **1***.i* is preferably machined from an aluminum block, to accept all components. An auto-safety pin **1***.j* is slidably mounted in a cylindrical channel machined between the safety **1***.k* and the claw **1***.b*. When the claw **1***.b* is cocked with a string, the auto-safety pin **1***.j* is forced rearward, and, in turn, moves the safety **1***.k* into contact with rear portion of lower sear **1***.h*, placing the trigger in a safe position. The safety **1***.k* pivots around the safety pivot point **1***.t*. A trigger **1***.u* is attached to the lower sear **1***.h*.

[0029] FIGS. **3***a*, **3***.b* and **3***.c* are respectively a top view, a frontal view, and a perspective view of the lower sear of a preferred embodiment the present invention. In these figures, the lower sear **1***.h* is fitted with two wings **1***n*.**1** and **1***n*.**2**. Each of these two wings has two bearing pockets **1***.o*.**1** and **1***.o*.**2**, between which a dowel pin **1***.p* is rotatably fixed. A threaded orifice **1***.q* is machined into **1***.h* to affix the trigger arm **1***.u* to lower sear **1***.h*.

[0030] FIG. **4** depicts the top view of the two halves of the housing **1***.i*, shown in exploded (apart) configuration. A spring pocket **1***.l* is machined into the bottom of housing **1***.i*, providing biasing means (a spring) for lower sear **1***.h* to be pushed against, engage and hold upper sear **1***.b* when upper sear is moved to its loaded position. The spring pocket **1***.l* is threaded with a blind set screw at the bottom portion; the screw has the ability to be moved in and out, allowing tension adjustment of spring **1***.n*, thus allowing the trigger pull to be adjusted based on an incoming pressure of upper sear **1***.b* that may be **100** lbs. to **400** lbs.

[0031] As shown in FIG. **4**, also machined into the bottom of housing **1***.i* is a set screw **1***.m* that allows the further adjustment of lower sear **1***.h* (impinging on wing **1***.n*.**2**), to enable proper angle of lower sear **1***.h* relative to the bottom of housing **1***.i*; this angle is critical to maintain lower sear **1***.h* at a parallel position to the bottom of housing **1***.i*.

[0032] Also in FIG. **4**, part **1***.a* is the pivot point for the claw **1***.b* and **1***.t*. is the pivot point for the safety **1***.k*. The embodiment being described herein utilizes an upward opening claw or string retaining means, the lower portion of this has a sear surface which when pulled back forces the keeper or holding sear portion out of the way allowing the bow to be cocked. Sear engagement in the present embodiment is the amount the sear surfaces overlap at the 90-degree

intersection. The lower sear portion is attached in this case to a trigger arm, which is pulled rearward to activate the firing of the crossbow it is spring tensioned to always be in an engaged state. The sear in this case on the lower engaging sear area is a 0.125" or ⅛" dowel pin; we know the circumference is described as 0.125"×3.14=0.3925", if we divide this by 360 degrees we know that the round dowel sear when allowed to engage the preferred flat sear surface would do so on an area described as 0.001" (one thousandth of an inch). The rotation of such a sear is achieved through the use of an outward roller bearing on both the left and right hand side of the lower sear, this allows the upper sear when pushing back ward to move the dowel down and under it's spring biasing means returning back to its position to hold the sears in place ready for discharge. The rolling action of the two bearings have an extremely efficient friction coefficient, coupled with a reduced contact area of 0.001" of an inch on one sear surface allow for such a light trigger pull that effecting the trigger pull to the required 3 lbs. or so can be adjusted through the use of a spring pocket that has a threaded insert in it allowing varying tension adjustment for the lower sear through the said spring biasing means. The spring tensioning allows the trigger geometry to stay the same maintaining the integrity of the internal components, while maintaining optimal sear engagement at all times through a two contact point rolling sear surface.

Operation of the Preferred Embodiment

[0033] The trigger described above would be installed in a crossbow; to load it, the user would place the crossbow on the ground supported by one foot, usually in a stirrup. The user would then grab the string with left and right hands and pull back on the crossbow string. The string would be pulled into opening **1**.*c* and this rearward movement will cause claw **1**.*b* to move rearward, forcing lower sear **1**.*h* to pivot about it pivot point **1**.*g*; this movement will also cause pin **1**.*j* to force safety **1**.*k* to pivot about **1**.*t*, placing the safety into a safe position because it interferes with the rear portion of lower sear **1**.*h*. The upper sear surface **1**.*f* will come and engage against dowel pin **1**.*p*, which is preferably a 0.125" diameter dowel pin. The crossbow is now ready to load an arrow for firing at a later time.

[0034] To fire the user will move safety **1**.*k* into the fire (or unsafe) position and depress the trigger **1**.*u* which is rigidly attached to lower sear **1**.*h*. This action will cause lower sear **1**.*h* to pivot, allowing claw **1**.*b* to pivot upward, thus disengaging upper sear surface **1**.*f* from dowel pin **1**.*p*, and fire the arrow.

[0035] While the foregoing written description of the invention enables one of ordinary skill to make and use what is considered presently to be the best mode thereof, those of ordinary skill will understand and appreciate the existence of variations, combinations, and equivalents of the specific embodiment, method, and examples herein. The invention should therefore not be limited by the above described embodiment, method, and examples, but by all embodiments and methods within the scope and spirit of the invention. For example, embodiments of this invention can be used for any other devices that use a trigger, such as guns, rifles, pistols, slingshots, etc. Similarly, adapting a long rod or an arm to replace or to actuate the trigger **1**.*u* of the embodiments herein, could. enable the positioning of a trigger far from the action, such as in a bull pup configuration.

What is claimed as the invention is:

1. A crossbow trigger mechanism comprising:

a) a housing adapted for installation in a crossbow stock;

b) a forward-opening bowstring entry area in the upper portion of said housing for receiving a bowstring;

c) a one-piece trigger pivotally installed in a lower portion of said housing, said trigger comprising a trigger arm extending downwardly from the trigger pivot point and out of the case and a first sear having a first sear surface;

d) a bowstring retaining claw connected to a second sear having a second sear surface;

whereby, when a bowstring is retained by said bowstring-retaining claw the first sear surface engages the second sear surface;

whereby, when said trigger is pulled rearwardly, first sear surface disengages from the second sear surface, and, whereby by virtue of the force produced by bowstring tension, the bowstring retaining claw pivots upwardly away from said bowstring entry area, thereby releasing said bowstring to project an arrow or other projectile;

whereby at least one of the first sear surface and the second sear surface is a pivoting pin mounted on roller bearings.

2. The crossbow trigger mechanism of claim **1**, further comprising

a manual safety lever having a safe position and a fire position;

an auto-safety pin

whereby, when a bowstring is retained by said bowstring-retaining claw, said auto-safety pin moves said manual safety lever to the safe position.

* * * * *