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LONGITUDINALLY ADJUSTABLE GOLF CLUB INCLUDING HEAD WITH HIGH MOMENT OF INERTIA ABOUT TWO AXES

Filed July 28, 1965 3 Sheets-Sheet 1

Fig. 1

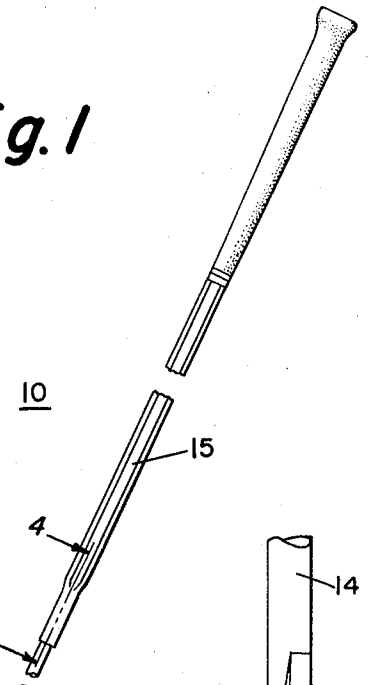


Fig. 2

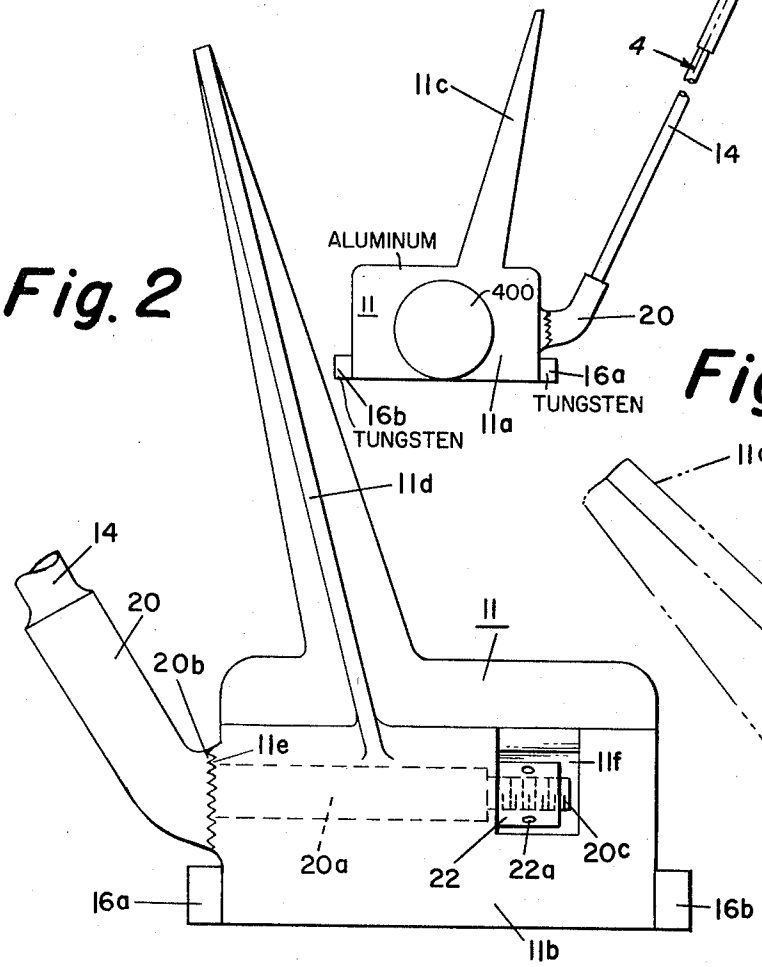
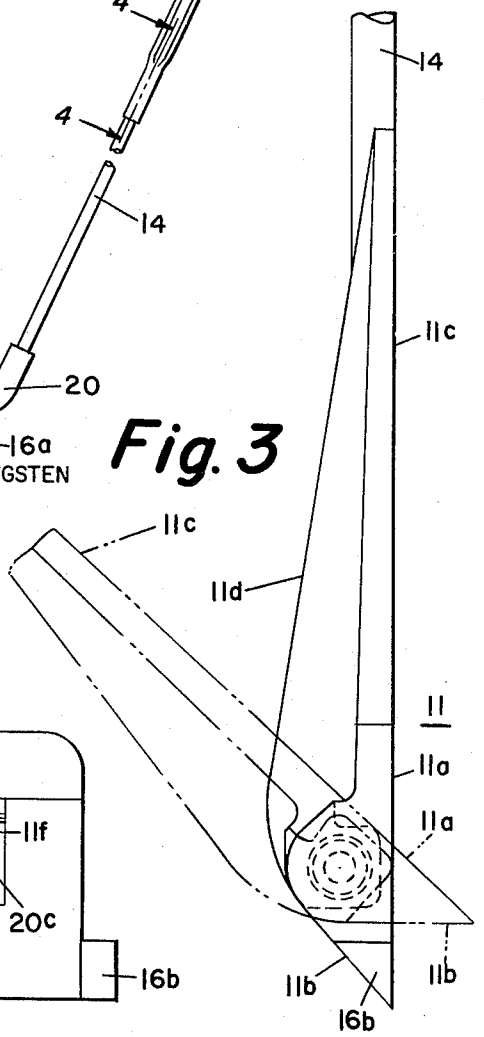


Fig. 3



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LONGITUDINALLY ADJUSTABLE GOLF CLUB INCLUDING HEAD WITH HIGH MOMENT OF INERTIA ABOUT TWO AXES

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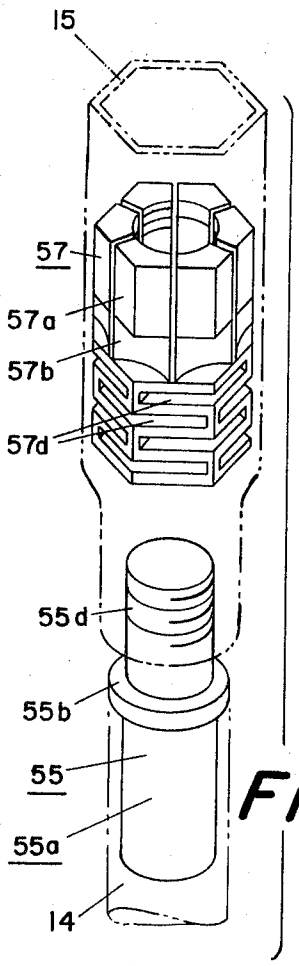


Fig. 9

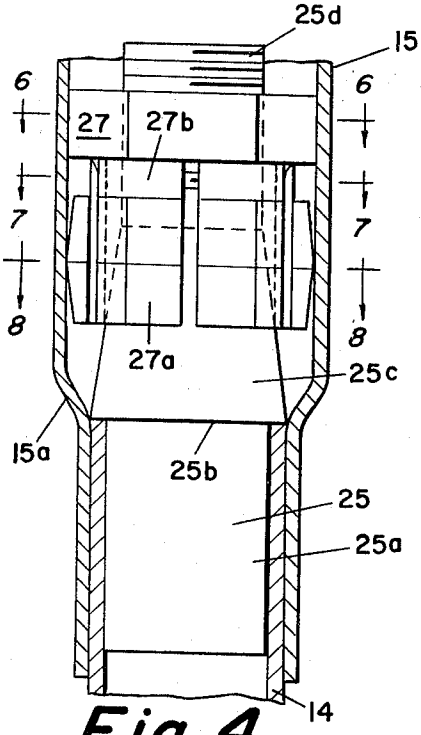


Fig. 4

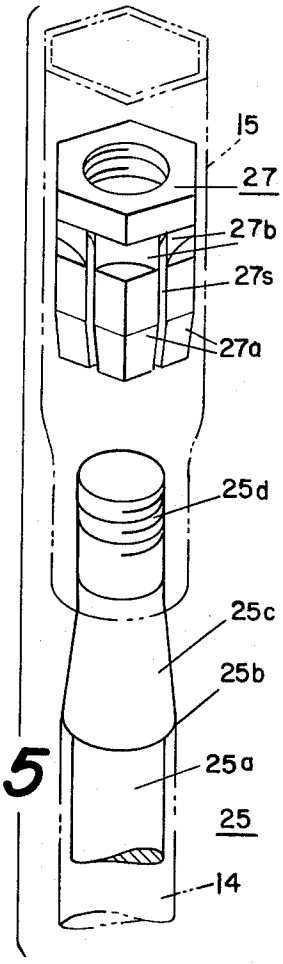


Fig. 5

Fig. 6

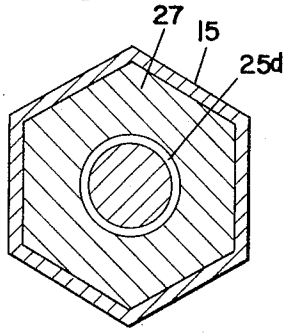


Fig. 7

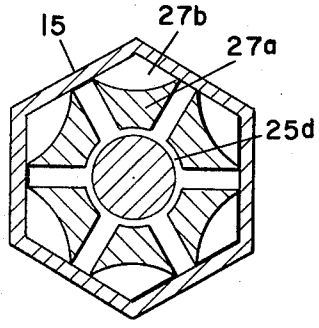
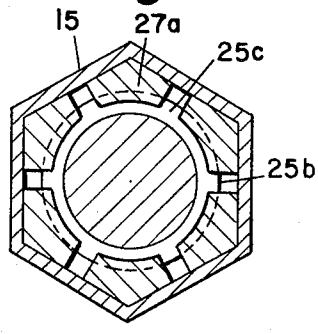


Fig. 8



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LONGITUDINALLY ADJUSTABLE GOLF CLUB INCLUDING HEAD WITH HIGH MOMENT OF INERTIA ABOUT TWO AXES

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Fig. 10

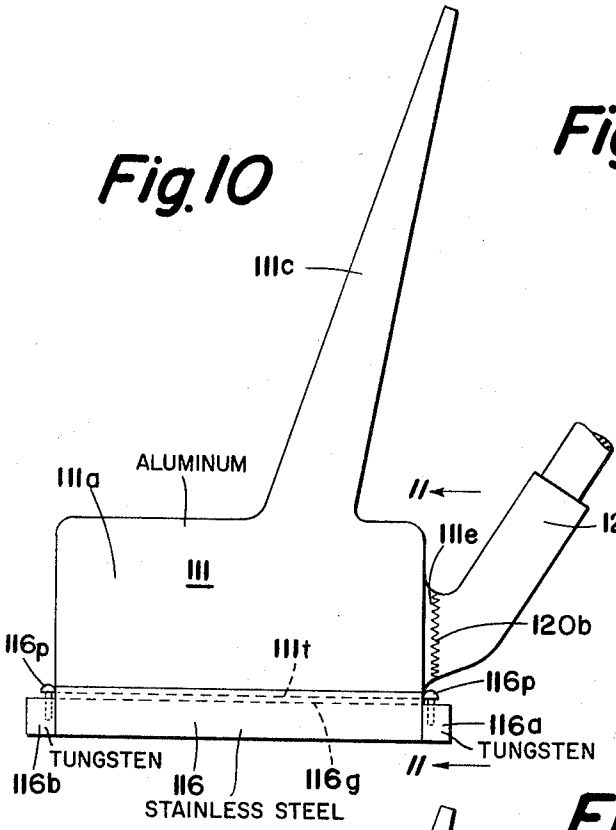


Fig. 11

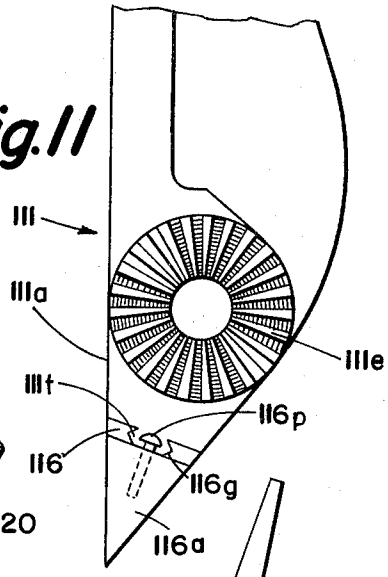


Fig. 12

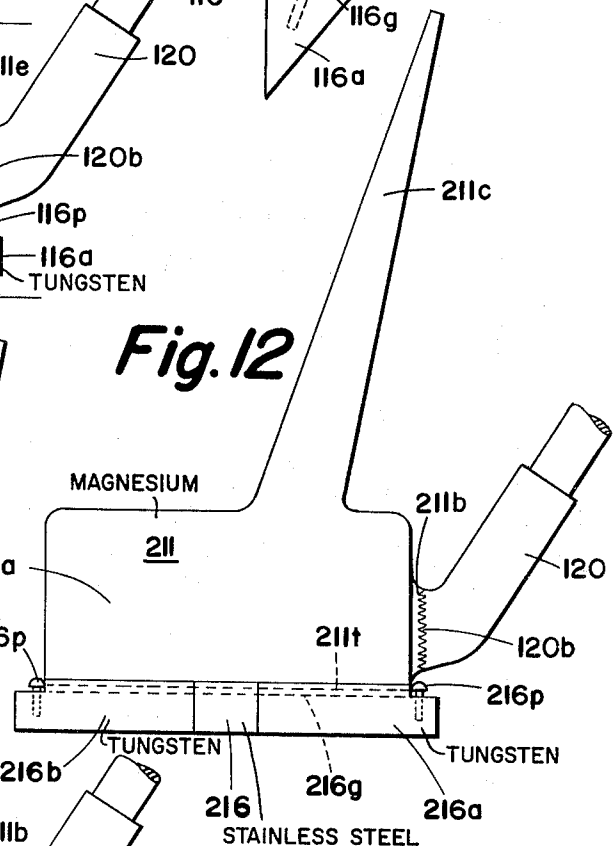
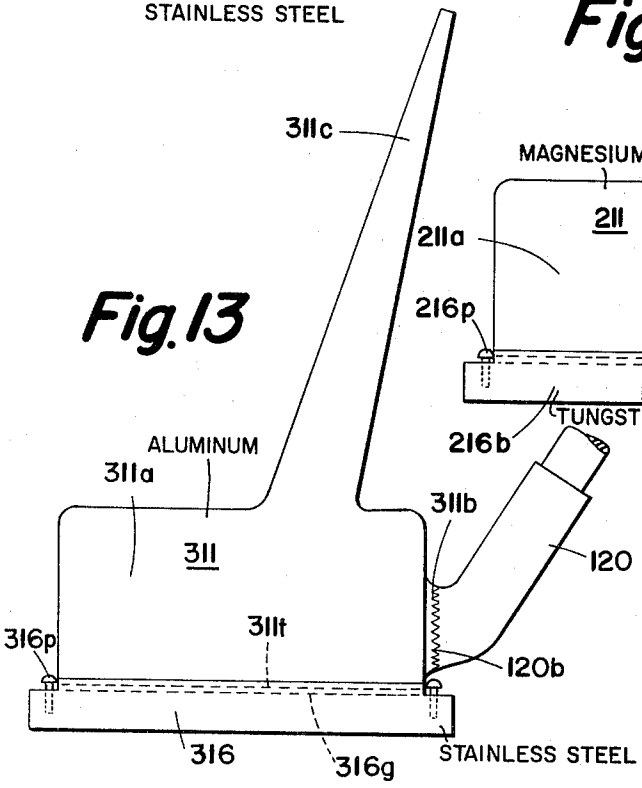


Fig. 13



United States Patent Office

3,305,235

Patented Feb. 21, 1967

3,305,235

LONGITUDINALLY ADJUSTABLE GOLF CLUB INCLUDING HEAD WITH HIGH MOMENT OF INERTIA ABOUT TWO AXES

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Filed July 28, 1965, Ser. No. 477,651
20 Claims. (Cl. 273—81.2)

This application is a continuation-in-part of parent application Serial No. 242,295, filed December 4, 1962, now abandoned.

This invention relates to an adjustable golf club and has for an object the provision of an improved adjustable golf club which is intended to make all of the shots required in any round of golf, thus avoiding the need for a plurality of clubs.

Different golf shots require different loft and different shaft length, more loft to get the ball higher into the air and more shaft length to get higher club head velocity, and, hence, greater ball velocity and distance. While numerous golf clubs with adjustable loft and adjustable shaft length have been made heretofore, they have left something to be desired particularly in regard to head construction and in regard to the length adjusting means.

The present invention involves improvements in all purpose or adjustable golf clubs by providing a head which is designed to minimize or reduce the extent of the spoilage of off-center shots, i.e., where the golfer does not bring the center of mass of the club head directly toward center of mass of the ball and by providing an adjustable shaft which is more reliable, more durable, and more convenient to adjust.

In accordance with one aspect of the invention, there is provided a golf club head comprising a blade having a striking face and a sole extending at an acute angle to the striking face so as to form the leading edge of the blade. The body structure of the blade is made of relatively light-weight material, such as aluminum or magnesium alloys, and weight structure of greater density than the body structure of the blade material is positioned to form the opposite ends of the leading edge. The weight structure provides the club head with a larger moment of inertia about a vertical axis than the moment of inertia of the blade in the absence of the extending weight structure while keeping the center of mass of the club head close to the striking face. To provide the club head with a larger moment of inertia about a horizontal axis, the blade is provided with an elongated projection which extends above the striking face a distance greater than the diameter of a golf ball for the exclusive purpose of providing the club head with a moment of inertia about the horizontal axis larger than the normal moment of inertia of the blade in the absence of the projection.

Further in accordance with the invention, the golf club is provided with an adjustable shaft comprising two sections which are adjustable as to overall length. The adjustable shaft comprises a shaft section having at the lower end thereof means for attachment of a head, the upper end of the shaft section including a very gradually sloping portion and being terminated in a threaded portion. A threaded nut member is carried by the threaded portion of the shaft section, and a hollow handle section is slidably mounted on the shaft section. The handle section has a cross-section in the shape of a polygon and corresponding to the shape of the nut member which is received therein. The nut member is adapted to be very gradually tightened and loosened upon relative rotation between the shaft and handle sections. The nut member is slotted axially on each of its sides and includes integral expanding leg portions which upon tightening of the nut on the shaft section causes the leg portions to engage the very gradually sloping portion and thus expand outwardly against the inner surface of the handle section for frictionally interlocking the handle and the shaft sections at a selected overall length.

For further objects and advantages of the invention and for a more detailed description thereof, reference is to be had to the following description taken in conjunction with the accompanying drawings in which:

FIG. 1 is a front elevation of an adjustable golf club embodying the present invention;

FIG. 2 is an enlarged rear view of the club head shown in FIG. 1;

FIG. 3 is a right-hand view of FIG. 2 showing two adjustment positions for the head;

FIG. 4 is a sectional view of the preferred form of shaft adjusting means taken along the line 4—4 in FIG. 1;

FIG. 5 is a exploded view in perspective of the parts shown in FIG. 4;

FIGS. 6, 7 and 8 are sectional views taken along the lines 6—6, 7—7, and 8—8 in FIG. 4;

FIG. 9 is an exploded perspective view of a modification of the shaft adjusting means;

FIG. 10 is a front elevational view of a modification of an adjustable golf club head embodying the present invention;

FIG. 11 is an end view of the blade taken in the direction 11—11 in FIG 10; and

FIGS. 12 and 13 are front elevational views of additional modifications of adjustable golf club heads embodying the present invention.

Before referring to the specific features of the club **10** illustrated in the drawings, it is believed that it will be helpful to first describe the theory in the design of the club. It is well known that in a conventional set of clubs, the ones designed for the shorter shots have the heavier heads and shorter shafts. As the number of the "iron" decreases, the weight of the head is reduced and the length of the shaft is increased and the velocity and distance is also increased. The same thing is true for the "woods." The No. 1 wood has a lighter head and a longer shaft than the No. 1 iron and it gives greater velocity and distance than the No. 1 iron.

In order to give comparable distance, the adjustable club **10** to be described herein has essentially the same weight in its head as a No. 1 wood. The shaft length of the improved adjustable club **10** can be made less than, equal to, or several inches greater than the No. 1 wood, depending upon the shot to be performed.

The basic requirements for a golf club can be explained by considering two important shots. The first of these is the first shot on each hole, namely, the tee shot, which is made with the ball disposed on a tee to elevate it above the surface of the ground. The second shot is commonly known as the fairway shot which must be made with the ball lying on the ground where it came to rest after the tee shot. In a tee shot the golfer tries to bring the center of mass of the club head toward the center of mass of the ball. Since the ball is elevated above the ground on a tee, the ground does not interfere with this action. If the golfer achieves his objective and if the club face is horizontally normal to its direction of travel at the instant of impact, the ball will take off normal to the club face. The ball's velocity will be the maximum possible under the existing conditions for the club head velocity achieved just prior to impact. However, the golfer does not always succeed in bringing the center of mass of the club head directly toward the center of mass of the ball, in which case the shot is spoiled more or less.

While the facts in the foregoing paragraph are well known, the way that the shot is spoiled, the extent to

which it is spoiled, and the factors in club design which tend to reduce the spoilage, are apparently not known, and it is an object of the present invention to provide a club which overcomes these difficulties.

One way in which a golf shot is spoiled by an "off-center" hit is explained in my technical paper ASME–57–IRD–13 entitled, "Some Dynamics of the Golf Shot." In that paper there is explained how an "off-center" hit with a wooden club tends to impart spin to the ball. The actual spin is a result of several tendencies and the curvature in flight (hook or slice) is the result of actual spin and not just the result of one tendency to impart spin. If the ball is hit with the toe of the wooden club, the tendency is to impart a counterclockwise spin (a hook) to the ball, and if the ball is hit with the heel of the wooden club, the tendency is to impart a clockwise spin (a slice). By way of explanation, the ball pressing on the toe of the club imparts a clockwise acceleration to the club head, and the club face, which is well in front of the center of mass of the club head is, therefore, accelerated away from the golfer.

The ball gets away before the angle of the club face in space has time to change by any significant amount. However, the ball does not get away before the direction of travel or "course" of the club face has changed, so the angle of the club face to its "course" has been altered in the hooking direction. A similar explanation is applicable as to why a ball hit with the heel of the wooden club tends to slice. This effect is negligible in an "iron" where the face is only a short distance in front of the center of mass of the club head. It is believed that this is the reason that an "iron" shot is apt to finish closer to the intended direction than a "wood" shot.

The present invention is concerned with a club which retains this advantage of the iron club and adds characteristics ordinarily available only in the woods. These desirable characteristics has been added while retaining the adjustable feature so these characteristics are available for all types of golf shots.

One of the desirable characteristics of the woods is the lightness of the head and the longness of the shaft, and these features contribute to the greater club head velocity, greater ball velocity, and greater distance achieved with the woods. Referring to FIG. 1, it will be seen that my improved adjustable club **10**, while of the "iron" type, nevertheless retains the beforementioned desirable features of a wood. The club **10** is provided with a head having a blade **11** which is mostly composed of an aluminum alloy to keep it light. The shaft of the club **10** comprises two sections, the first of which is a shaft section **14**, and the second of which is a hollow handle section **15**. As later to be described more in detail, this two-section shaft gives a total shaft length which can be as long, or longer, than any conventional wood.

A second desirable characteristic of the woods results from mass distribution in the club head. The shape of the wooden club head approaches that of a short cylinder with a vertical axis. This shape gives a relative high moment of inertia about a vertical axis because a large portion of the mass is at a large distance from the center. This can be understood by dividing the cylinder into a number of "pie-shaped" sections and noting that the center of mass of each section is nearer the rim than the axis. The shape of an "iron" more closely approximates a bar which does not have a large portion of its mass at a large distance from its center. If the iron had a weight equal to the wood and its length (from heel to toe) were equal to the diameter of the wooden head, its moment of inertia would be considerably less than that of the wood. For such an iron, a hit off-center by x millimeters would result in a greater loss of ball velocity than for a hit on the wood off-center by the same x millimeters. By calculations, it can be shown that a ball caught off-center on the face of an iron by $\frac{1}{5}$ of the length of the iron head will lack about

$\frac{1}{10}$ of the velocity it would have had if caught on-center. A ball which takes off with a deficiency of 0.1 in velocity can land in all sorts of undesirable places such as sand traps, water hazards, etc., so a golfer strives to perfect his swing to minimize off-center hits.

The present invention approaches the problem from the standpoint of what can be done in the design of the club to reduce the spoilage from an off-center hit. One approach would be to make a club head longer. Thus, the golfer could make the same error in millimeters but it would be a smaller fraction of the club head length; therefore, his loss of velocity would be less. While a small step may be taken in this direction, a large step is not desirable in order to avoid increasing the amount of grass to be cut by a longer club head on its way to the ball. The problem is to keep the club head reasonably short to avoid cutting excess grass yet to have it act like a longer club head so as to reduce the spoilage on off-center hits. The only reason that a longer club head (with the same total mass) gives reduced spoilage for off-center hits is its larger moment of inertia about a vertical axis. The larger moment of inertia prevents the club head from spinning so fast (as a result of the off-center hit) and thus cuts the loss of velocity at the point of contact with a resulting cut in the loss of velocity of the ball. If enough moment of inertia (with the same total mass) could be obtained to keep the spin of the club head negligible, the spoilage from any off-center hit would be negligible.

In accordance with the present invention, there is conceived what may be referred to as an "ideal" club head where half of the mass of the club head is concentrated at the heel and the other half of its mass is concentrated at the toe. The structural material between the heel and toe should have negligible mass but adequate strength and stiffness. Such a club head would give the maximum moment of inertia for the prescribed club head mass and the prescribed club head length. By calculation it can be shown that a club head with uniform mass distribution from heel to toe, which has the same total mass as the "ideal" club head, will be longer than the "ideal" club head, the ratio of length being the square root of three. Stated differently, an "ideal" club head having the same tolerance for off-center hits of the same amount in millimeters would be only .578 times as long as the club head with uniform mass distribution. The saving in the amount of grass to be cut through is desirable even though only a small portion of this saving is available with existing materials of construction. It will, of course, be understood that the above club head which has been referred to as the "ideal" club head is one we can only approach with actual materials available for construction.

It is believed that the foregoing theory will enable the reader to more easily understand the construction of the club as now to be described in detail. Referring to FIGS. 1–3, it will be seen that the club **10** is provided with a head having a blade **11** including a striking face **11***a* and a sole **11***b*, FIG. 3, extending at an acute angle to the striking face so as to form the leading edge of the blade. The body structure of the blade **11** is made of relatively light-weight material in order that the weight may be concentrated at the heel and toe of the blade. The material from which the blade **11** is made must not only be of light weight, but it must also have adequate strength for striking the ball. It has been found that aluminum alloys and magnesium alloys have such desired characteristics. Such alloys may be obtained commercially, for example, airplane aluminum. As may be seen in FIGS. 1–3, the heel and toe portions of the blade **11** have been provided with weight structure in the form of members **16***a* and **16***b* and which are positioned to form the opposite ends of the leading edge of the blade **11**. The weights **16***a* and **16***b* are of greater density than the blade material, thus providing the club head with a larger amount

of inertia about a vertical axis. In the preferred form of the invention, the weight structure should have more than twice the density of the body structure of the blade.

In an "ideal" club head, in addition to having weight concentrated at the heel and toe of the head, it is also desirable to have a small mass positioned well above the leading edge in order to provide a moment of inertia about a horizontal axis. Such moment of inertia is important in reducing loss of ball velocity from hits above or below the center of mass of the club head. To increase the normal moment of inertia of the blade **11** about a horizontal axis, the blade **11** is provided with an elongated projection **11***c* which extends in a generally upwardly direction above the striking face **11***a* a distance greater than the diameter of a conventional golf ball 400. Golf balls having a diameter of about 1.68 inches are generally considered as conventional in North America. The front face of the projection **11***c* is in the same plane as the striking face **11***a*, FIG. 3. As may be seen in FIG. 2, the projection **11***c* is in substantially T-shaped cross-section with the trunk portion of the tee section **11***d* extending at substantially right angles to the cross bar of the T. Since each section of the elongated projection **11***c* must withstand the cantilever action of all above it, the cross-sectional area of the projection **11***c* continually increases, thus tapering from a relatively narrow upper end to a relatively wide base where the projection **11***c* joins the striking face **11***a* of blade **11** intermediate the ends thereof. The cross-sectional area at the top of the projection **11***c* starts small in order to avoid excessive size and weight at the bottom of the projection **11***c*.

A club head constructed in accordance with the foregoing description was machined from a solid piece of airplane aluminum alloy. The rectangular striking face **11***a* of the blade **11** was approximately 3¼" by 2" and the projection **11***c* extended about 6½" above the bottom edge of the blade. Thus it will be seen that the projection **11***c* extended above the striking face a distance greater than one diameter of a conventional golf ball and a total distance from the leading edge greater than two diameters of a conventional golf ball. The extension **11***c* was provided with a diminishing extension **11***c* and the T section was inclined towards the heel of the club head with the upper end of the extension **11***c* being in line with the heel end of the blade so as not to interfere with machining the blade for receiving a club handle. The heel and toe of the club head were provided with tungsten weights **16***a* and **16***b* which were bonded thereto in suitable manner by means of silver solder, in combination with a zinc base aluminum solder. The tungsten weights **16***a* and **16***b* consisted of a combination of sintered tungsten and copper powders. This material had a specific gravity of about sixteen which is twice that of bronze and steel and about six times that of aluminum and its principal alloys. A club head constructed according to the foregoing requirements has given considerable tolerance for hits above and below center and to either side of center relative to the heel and toe of the club head. It is to be understood that a magnesium alloy may be used in place of the aluminum alloy, and since the former is only a fraction of the density of the latter, this reduction in weight in the blade body structure could be used by adding to the concentrated weights, thus increasing the moment of inertia further without increasing the club head weight. As pointed out above, the optimum weight of the club head is predetermined in accordance with the weight of the head of a normal wooden driver. As mentioned earlier, it is desirable to keep the center of the mass of the club head close to the leading edge. However, there are several factors that tend to pull the center of mass away from the leading edge. One of these factors involves the permissible angle between the sole and the face of the club head to provide the desired amount of loft. The greatest amount of loft normally used in golf clubs is about 55° from the vertical, or to be more exact about 55° from the plane containing the leading edge and parallel to the axis of the shaft. In order to take advantage of this loft angle in any shot, the leading edge should be at or below the point where the ball hits the flat face **11***a* of the club head. It is also desirable that the sole **11***b* of the club should not hit the ground, which may be hard, before the face **11***a* makes contact with the ball. Ideally, the face **11***a* should make contact with the ball just as the sole **11***b*, including the leading edge, makes contact with the ground on which the ball is resting. By subtracting 55° from 90°, it would appear that 35° is the maximum angle permissible between the sole and the face of the club head. Actually, however, on lofted shots the hands of the golfer lead the club head at the instant of impact so that the club face is not as much as 55° back from the vertical. It has been found that club heads with an angle between face **11***a* and sole **11***b* of between 35° and 45° will give satisfactory performance without excessive ground interference. In other words, it has been found that an effective maximum loft angle can be obtained which is not a full 55°, thus permitting a greater angle between the club face **11***a* and the sole **11***b*, thereby moving the center of mass of the club head closer to the leading edge as desired.

A second factor tending to pull the center of mass away from the leading edge involves the manner of attachment of the shaft to the club head. As may be seen in FIG. 3, the club head is adjustable between a vertical position as shown in solid line in FIG. 3 and the inclined position as shown in phantom line in FIG. 3. The club head **11** is carried by an elbow **20**, FIGS. 1 and 2, which in turn is carried at the lower end of shaft section **14**. In order to minimize weight where it is not wanted, since this elbow is spaced from the leading edge of the club head, the elbow **20** is made from a light-weight material such, for example, as an aluminum alloy. An elbow constructed in accordance with the present invention weighed about one ounce and the angle between the shaft connecting portion and the axle **20***a*, which extends in an opening in the rear portion of the head **11**, was about 122°. This angle prevents the toe of the club from riding high when the shaft is adjusted to a long length for driving. In a manner well known in the art, the elbow **20** is provided with a series of serrations or teeth **20***b* which are adapted to engage a corresponding series of serrations or teeth **11***e* at the heel end of the club head and which are distributed around the opening in the club head into which the axle portion **20***a* extends. As may be seen in FIG. 2, the end of the axle portion **20***a* is provided with a threaded portion **20***c* which extends into a recess **11***f* cut in the rear side of the blade **11** adjacent the toe end. A locking nut **22** is threaded onto the threaded portion **20***c* of elbow **20**; and when it is tightened against the left-hand side of recess **11***f*, it locks the blade **11** and elbow **20** in fixed relation at an angle predetermined by the engagement of teeth **11***e* and **20***b*. The nut **22** is provided with openings **22***a* which are adapted to engage the teeth of a wrench to enable the nut **22** to be quickly tightened or loosened when changing the position of the club head for different shots.

While some adjustable head clubs have been provided with shafts of fixed length, this is undesirable since the length of shaft should vary with the length of shot to be made. In other words, for longer shots, a longer shaft should be employed, whereas for a shorter shot, a shorter shaft should be employed. While some adjustable clubs in the past have been provided with shafts of adjustable lengths, they have left much to be desired particularly in regard to durability and ease of adjustment. The principal problem in adjustable length shafts has been in the clamping mechanism. Some of these prior clamping mechanisms have been designed to tighten with a counter-clockwise torque with the assumption that more golfers would tend to hit the ball on the toe of the club and thus the golf shot would then tend to tighten rather than to

loosen the shaft. However, when the ball is hit on the heel, that is, inside the center of mass of the club head, the club head is given a spin which tends to loosen the shaft and often does. When the ball is caught outside the center of mass, that is, on the toe, there is no danger of the shaft losening but a hammer blow of this type, on an already tight mechanism, is frequently enough to tighten the mechanism so much as to split the shaft. Another approach in prior clamping mechanisms has been in the use of nylon nuts. While nylon nuts tend to tighten more slowly, they are subject to cold flow, a problem which is greatly increased in hot weather.

The foregoing problems of prior clamping mechanisms have been eliminated by the present invention, and the preferred embodiment of the present improved clamping mechanism is illustrated in FIGS. 4–8. The improved club **10** embodying the new clamping mechanism is shown in FIG. 1. As may be seen in FIG. 1, the elongated structure or shaft which is adjustable as to length comprises a first or shaft section **14** having at the lower end thereof means for attachment of the head **11**. The shaft **14** preferably is hollow as shown in FIG. 4 and at the upper end thereof is terminated in a threaded portion **25**. While portion **25** may be integral with the hollow shaft **14**, it is preferable that it be made from a separate member and inserted into the end of shaft **14** as shown in FIG. 4. The lower portion **25***a* of member **25** is of such diameter as to have a pressed fit within the tubular shaft **14**. The portion **25***a* terminates at its upper end in a shoulder **25***b* of enlarged diameter corresponding to the outer diameter of shaft **14**. The shoulder **25***b* forms the lower end of a gradually sloping conical portion **25***c*. Beyond the sloping or tapered portion **25***c* is a circular threaded portion **25***d*. The threaded portion **25***d* is adapted to receive a threaded nut member **27** of special construction. The upper solid end of the nut **27** is internally threaded for engagement with the threads on section **25***d* of the shaft **14**. The lower end of the nut **27** is provided with a plurality of longitudinal slots which provide the nut with integral expandable portions **27***a*. The nut **27** has a shape of a polygon corresponding to the shape of the hollow handle section **15**. The lower end of the handle section **15** is bent in at **15***a*, FIG. 4, to prevent the nut **27** from sliding out the open end thereof.

In the illustrated form of the invention, the handle section **15** has been provided with a hexagonal shape, and thus the nut **27** likewise is hexagonal in cross section. A longitudinal slot has been made in each of the six faces of the lower portion of the nut **27**, thus dividing this lower portion into the six expandable portions or legs **27***a*. A transverse groove **27***b* is provided at the upper ends of the legs **27***a* to provide in effect a spring hinge to aid the tapered surface **25***c* in expanding the legs **27***a* outwardly against the inside surface of the hexagonal shaft section **15**. The various sections of the nut **27** and its relationship to the threaded portion **27***d* and tapered portion **25***c* is shown in sectional views, FIGS. 6–8. As may be seen in FIG. 6, the threaded portion **25***d* is in engagement with the threaded portion of nut **27**, and in FIG. 8 it will be seen that the legs **27***a* of the nut **27** are forced outwardly by the sloping or tapered surface **25***c* into tight engagement at the **8—8** section, FIG. 4, with the inner surface of the hexagonal shaft section **15**. There is a lever action due to engagement of the inner surface of legs **27***a* at the lower or free ends thereof with the tapered surface **25***c* and the outer surface of legs **27***a* adjacent the bevel line, FIG. 4, with the inner surface of the hexagonal shaft section **15**.

By reason of the foregoing construction of the clamping mechanism, notably the gradual slope of the taper, the fineness of the threads and the lever action of the legs, the tightening angle for the shaft is substantially increased, thereby reducing the frequency of shaft unclamping from off-center hits to zero. Since the tightening of the shaft requires many degrees, in the order of 45° or more, the energy from any off-center hit will be absorbed without splitting the hexagon shaft. Thus, the new and improved clamping mechanism has eliminated the two principal objections to extendible shafts, namely, the loosening of the mechanism due to off-center hits, or the cracking or the splitting of the shafts due to off-center hits, depending upon which side of center the ball is hit.

In one specific example of the invention, the member **25**, FIGS. 4 and 5, was constructed of cold rolled steel and had an overall length of about 2¼″. The portion **25***a* had a length of about 1⅛″ and a diameter of about .440″. At the shoulder **25***b*, at the bottom end of cone **25***c*, the diameter increased to .470″ and tapered inwardly at approximately 6° for the next 7/16″ where the diameter was reduced to about ⅜″ and continued at ⅜″ for 11/16″ to the up-shaft end of the screw. The threaded portion **25***d* was provided with a ⅜″ x 16 thread for approximately ½″ or to within 3/16″ of the tapered section **25***c*. The nut **27** had an overall length of ⅝″, the thread on the nut was a standard V thread ⅜″ x 16 and extended for only 3/16″ from the upper end. From the end of the thread to the lower end of the nut **27**, the hole was ⅜″ in diameter. The lower end of each face of the nut **27** was beveled, FIG. 5. The bevel extended for 3/16″ up each face and extended about 1/64″ into the lower end of the nut **27**. Each face was provided with a slot **27***s* about 1/32″ wide starting from the middle of the unthreaded end extending toward the threaded end. The inside end of each slot terminated where the thread began which was 3/16″ from the upper end of the nut. The angle of the end of the slot **27***s* was about 45°, making the outside of the slot **27***s* longer than the inside. On each leg **27***a*, there was a ⅛″ transverse slot **27***b* cut to such depth as to just meet the axial slots **27***s*. Each of the slots **27***b* was centered over the end of the thread on the interior of the nut **27**. The nuts **27** were constructed of an aluminum bronze material, the combined weight of the nut and screw being about .9 ounce. Screws made of aluminum alloy have also been constructed and found to work satisfactorily when the cones were made as thin steel sleeves. They were slipped over the small threaded ends of the screws and fastened with taper pins before finishing. The combined weight of such a screw and nut was about .7 ounce. It has also been found that the screw members **25** may be provided with a screw thread of 5/16″ x 24. This allows an inside diameter of the cone of 5/16″ yet the inside diameter of the nut where it engages the cone is ⅜″ so the cone thickness at the point of engagement is 1/32″ which provides plenty of strength. By increasing the threads from 16 to 24 per inch and keeping the cone angle essentially the same, the tightening angle is proportionally increased as is the loosening angle, thus enhancing the performance of the shaft clamp.

The foregoing improved construction of the clamping mechanism has numerous advantages. The cone on the shaft is larger than the screw yet the tightening torque is low because of the lever action in the legs of the nut. Splits in the hex shaft are avoided because the nut and screw are designed to tighten very gradually and as a result the twisting energy from any off-center hit is absorbed before stress on the hex shaft can be increased to the splitting value. The nut is slotted in the center of all six faces so that the only stress on the hex shaft is simply tension across its flats with no extra stress at the corners. Bending of the lower shaft **14** is avoided because of lightness in the nut and in the screw. Unclamping and lengthening of the shaft from off-center hits is avoided because the nut and screw are so designed as to tighten so gradually and loosen so gradually that the twisting energy from any off-center hit is absorbed before the parts have turned a sufficient amount relative to each other to unclamp the device.

A modification of the clamping device is shown in FIG. 9. In FIG. 9, a threaded member **55** is disposed in the end of the hollow shaft section **14**. The member **55** is provided at its lower end with a portion **55***a* which has a diameter adapted to form a pressed fit with the inner circumference of hollow shaft **14**. The shoulder **55***b* on

member 55 is adapted to abut against the end of the tubular member 14. The upper end of member 55 is provided with a threaded portion 55*d* of appropriate diameter for receiving a threaded nut member. The threads on the inside of the nut have a sawtooth shape. The face of the thread used for tightening makes an angle of only about 23 degrees with the axis of the nut so that the expanding action on tightening is more gradual than with the steep face of a conventionally-shaped thread. The thread shape on the screw may be conventional but to reduce wear, it should preferably have a shape complementary to that of the nut. In nut 57, the upper portion which is threaded is provided with axial slots in each of the six faces, thereby providing the nut with six leg portions 57*a*. Transverse slots 57*b* are provided in each of the legs 57*a* for hinging action. The nut 57 is somewhat longer than the nut 27 since the lower end of the nut 57 is provided with a relatively long unthreaded portion which is given axial springiness by cutting overlapping transverse slots 57*d* of slightly less than 120°. This axial spring must be compressed in tightening the shaft which means that the threaded end of the nut 57 and the hex shaft section 15 into which it extends must be turned through a greater number of degrees to tighten and to loosen the handle section 15 relative to the shaft section 14. The leg portions 57*a* of the nut 57 are adapted to engage the inner surface of the hollow handle section 15 when the nut 57 is tightened on the screw portion 55*d*.

From the foregoing, it will be seen that the gradually sloping sides of the threads cause the leg portions 57*a* to expand and engage the inner surface of member 15 when the nut 57 is tightened. While the embodiment illustrated as nut 27 is preferred since it is lighter in weight than the longer nut 57, nevertheless, the modification illustrated in FIG. 9 has been found to be satisfactory in eliminating the aforementioned problems resulting from off-center hits.

While the club head utilizing the construction of blade 11 and the weight members 16*a* and 16*b*, as shown in FIGS. 1–3, closely approximates the "ideal" club head with regard to tolerance for off-center hits, other structural modifications in the club head may be made while at the same time retaining a substantial tolerance for off-center hits. For example, in order to avoid nicks in the leading edge of the blade and thus provide for longer wear, the entire leading edge of the blade may comprise the weight structure and thus be of greater strength and density than the body structure of the blade to which the weight of structure is attached. Such construction is illustrated by the modifications shown in FIGS. 10–13.

In the modification of FIG. 10, the body structure of the blade 111 is made of relatively light-weight material such, for example, as aluminum. At the lower portion of the striking face 111*a*, there is provided weight structure which extends throughout the full length of the blade 111 and forms the entire leading edge. The weight structure comprises a sandwich structure including a center layer or section 116 which has a density greater than the density of the bulk of the blade 111. The layer 116 preferably is made from a stainless steel or aluminum bronze which has approximately the same density. The end layers 116*a* and 116*b* of the weight structure extend beyond the body structure of blade 111 and have a density greater than the density of the center layer 116. The layers 116*a* and 116*b* preferably are formed of tungsten similar to the end weight members 16*a* and 16*b* in FIGS. 1–3. The tungsten extensions 116*a* and 116*b* are adapted to be secured to the ends of the center layer 116 by silver soldering or brazing a technique in the metal-joining art.

The weight structure comprising layers 116–116*b* and the body structure of blade 111 are provided with complementary configurations along their mating surfaces to provide interlocking engagement. For example, as may be seen in FIG. 11, the body structure of blade 111 is provided with a tongue structure 111*t* having a five-sided configuration. The weight structure layer 116 is provided in its mating surface with a groove 116*g* of complementary five-sided configuration to receive the tongue structure 111*t*. In constructing the head shown in FIGS. 10 and 11, the metals used to form the composite weight structure 116–116*b* are first strongly bonded together as by silver brazing. The weight structure is then machined to provide the groove 116*g* and the body structure of blade 111 is likewise machined to provide the tongue 111*t*. It will be noted that the tongue and groove are of the "claw" type so that the only movement of the weight structure can be in the longitudinal direction with respect to the body structure of blade 111. It is preferable to have a tight fit between the weight structure and the body structure of the blade. However, it is not necessary to have a tight fit at all five faces of the tongue 111*t* as only the upper two of the sloping faces of the tongue hold the weight structure against the body structure of blade 111. It has been found that an epoxy cement is useful in achieving tightness between the weight structure and the body structure of the blade.

As may be seen in FIG. 10, the extending portions 116*a* and 116*b* of the weight structure are each provided with drive pins 116*p* which project above the extension portions and are opposite the tongue portion 111*t* of the blade as shown in FIG. 11. These drive pins 116*p* at the heel and toe of the club head are adapted to prevent accidental detachment of the weight structure 116–116*b* from blade 111 in a horizontal direction and are not intended to provide the tightness between the weight structure and the body structure of the blade. The five-sided configuration for the tongue 111*t* is preferable to a three-sided dovetail as it avoids a possible shear failure in the tongue without using a wider tongue and, thus reducing the width of the neck in each claw of the weight structure. It is to be understood that other shapes for the tongue and the mating claws could be used and that the construction could be inverted by forming the tongue on the weight structure and the claws on the body structure of the blade.

In order to increase the normal moment of inertia of the blade 111 about a horizontal axis, the blade 111 is provided with an elongated projection 111*c* which is similar in construction to the projection 11*c* shown in FIGS. 1–3. The blade 111 is adapted to be carried by an elbow 120 similar to elbow 20 shown in FIGS. 1 and 2. The elbow 120 as well as the mating end, i.e., heel end, of the blade 111 are adapted to be provided with a series of serrations or teeth 120*b* and 111*e* respectively. The teeth are preferably five-degree teeth which, thus enable the adjustable club head to closely conform in performance to a full set of conventional clubs which have an interval of about five degrees in loft between club head faces.

In FIGS. 10 and 11 it will be seen that the weight structure 116–116*b* not only comprises the entire leading edge of the blade 111 but also is exposed on the striking face as well as on the sole of the club head. This construction keeps the center of mass of the head close to the leading edge and close to the striking face while providing the club head with a moment of inertia about a vertical axis larger than the normal moment of inertia of the blade in the absence of the weight structure or of a club head of similar size and weight with the weight structure otherwise positioned.

In a golf club head produced in accordance with the modification of FIGS. 10 and 11, the weight structure was produced from a composite rod including a center layer 116 comprising a piece of stainless steel $3\frac{3}{16}$ inch long, silver brazed between two end pieces 116*a* and 116*b* of tungsten which is about $\frac{3}{16}$ inch long each. The composite weight structure was machined to provide it with the groove 116*g* so that it would have a drive fit with the tongue 111*t* machined on the body structure of blade 111. The tops of the tungsten pieces 116*a* and 116*b* were cut

away so that they would not interfere with the slotting of the stainless steel piece **116**. The composite weight structure had a finished length dimension of 3 9/16 inches providing a projection of about 3/16 inch at the heel and a projection of about 3/16 inch at the toe. The head of the drive studs **116***p* were close to the ends of the aluminum blade **111**, i.e., not over 1/64 inch, and projected about 1/32 inch above the tungsten members **116***a* and **116***b*.

The modification shown in FIG. 12 is similar to the modification in FIGS. 10 and 11 with certain exceptions. The body structure of blade **211** in FIG. 12 is made from magnesium which has a density lower than the density of aluminum. Thus, in order to provide the club head with the optimum total weight, the weight structure, which forms the leading edge for the club head, includes larger pieces of tungsten. The weight structure comprises a center member **216** joined to the two outer tungsten members **216***a* and **216***b*. The center member, or layer, **216** is constructed from a material selected as a compromise between lightness and strength, such as aluminum, bronze or stainless steel. Thus, the tungsten members **216***a* and **216***b* may be bonded to the center layer **216** by the same method as described above for FIGS. 10 and 11. The blade **211** is provided with a striking face **211***a* and an elongated projection **211***c* for the same purpose as the corresponding projections in FIGS. 1 and 10. The blade **211** is provided with teeth **211***b* at the heel end which are adapted to mate with the corresponding teeth **120***b* on the elbow **120**.

The weight structure **216–216***b* may be produced from a composite rod including about 1/2 inch of bronze, or equivalent material, silver soldered between two pieces of tungsten, the latter pieces being about 1 17/32 inch long. The bronze and tungsten weight structure, when completed, has a length of about 3 9/16 inches providing a projection of about 3/16 inch at the heel and toe of the club head. The weight structure **216–216***b* is machined providing it with a groove **216***g*, FIG. 12, with the claws on the projecting ends being removed. The mating surface of the body structure of blade **211** is provided with corresponding tongue structure **211***t* which is adapted to extend into the groove structure **216***g*. The drive studs **216***p* are inserted in the end members **216***a* and **216***b* in manner similar to the drive studs **116***p* described above in connection with FIGS. 10 and 11. A view from the right-hand end, or heel end, of blade **211** is similar to the end view in FIG. 11.

The weight structure comprising layers **216–216***b* functions in a manner similar to the weight structure **116–116***a* in FIG. 10 and the weight structure **16***a* and **16***b* in FIGS. 1 and 2, in that it provides the club head with a moment of inertia about a vertical axis larger than the moment of inertia of the blade in the absence of the extending weight structure while keeping the center of mass of the club head close to the striking face. The elongated projection **211***c* extends above the striking face **211***a* a distance greater than the diameter of a golf ball for the exclusive purpose of providing the club head with a moment of inertia about a horizontal axis larger than the normal moment of inertia of the blade in the absence of the projection **211***c*.

Referring to FIG. 13, there is illustrated a modification of the invention in which the blade **311** is provided with a leading edge comprising a weight structure **316**. The body structure of blade **311** is made from a light-weight material, such as aluminum, while the weight structure **316** has a uniform density and is made from a material having a density at least twice as great as the body structure of the blade. Since the weight structure **316** is of uniform density throughout its length, the moment of inertia about a vertical axis for the club head shown in FIG. 13 is less than that of heads as shown in the previous modifications. However, the moment of inertia about a vertical axis of the head of FIG. 13 is greater than a head of similar size and weight in which the weight structure does not extend to the toe end and the heel end of the leading edge. The weight structure **316** is provided with a groove **316***g* which is adapted to receive the tongue **311***t* similar to the modifications shown in FIGS. 10–12. The drive pins **316***p* extend into the weight structure **316** and function in the same manner as drive studs **116***p* and **216***p* previously described. The blade **311** is provided at the heel end with teeth **311***b* which are adapted to mate with teeth **120***b* on the elbow **120** similar to the previous modifications.

The blade **311** includes an elongated projection **311***c* which extends above the striking face **311***a* a distance greater than the diameter of a golf ball for the exclusive purpose of providing the club head with a moment of inertia about a horizontal axis larger than the normal moment of inertia of the blade **311** in the absence of projection **311***c*. The weight structure **316** is adapted to have a length corresponding to that of the previously described weight structures and extends about 3/16 inch at the heel and toe of the club head. The weight structure **316** is adapted to position the center of mass of the club head closer to the leading edge than it would be without such weight structure while keeping the center of mass of the club head close to the striking face **311***a*.

From the foregoing description, it will be seen that the modifications shown in FIGS. 10–13 each has weight structures which extend throughout the full length of the blade of the respective club heads. Since the weight structures are of relatively strong materials, such as stainless steel, aluminum bronze, tungsten and the like, such club heads may be referred to as "armored heads." The armored head has the desirable characteristic in that it is less liable to damage from a collision with a hard stone than the head in which a portion of the leading edge is constructed of less dense and weaker metal such as the embodiment shown in FIGS. 1–3. However, the armored head has a moment of inertia about a vertical axis less than the unarmored head of the same shape and weight shown in FIGS. 1–3.

While the present invention has been described in connection with a golf club in which both the head and the handle are adjustable, it is understood that the invention is not limited to this particular combination. The improvements in the adjustable head are equally applicable in clubs where the shaft is not adjustable. Likewise, the adjustable features of the shaft are not limited to clubs having adjustable heads. The novel clamping mechanism of the adjustable shaft is applicable to any type of elongated structure which is adjustable as to length, and particularly where the adjustment is performed manually so that the tightening and loosening of the clamping mechanism can be accomplished easily without tools. Thus, it will be seen that the present invention is not limited to these specific embodiments illustrated but further modifications thereof may be made within the scope of the appended claims.

What is claimed is:

1. A golf club head comprising:

a blade having a striking face and a sole extending at an acute angle to said striking face, the body structure of said blade being of relatively light-weight material,

weight structure of greater density than said body structure of said blade positioned at the leading edge of said sole and extending to the opposite ends of said leading edge, said weight structure providing said club head with a moment of inertia about a vertical axis larger than the moment of inertia of said blade in the absence of said weight structure, and

an elongated projection extending above said striking face to provide said club head with a moment of inertia about a horizontal axis larger than the normal moment of inertia of said blade in the absence of said projection, said elongated projection extending above said striking face tapering from a relatively

wide base at the upper edge of said striking face to a relatively pointed upper end, said elongated projection having a T-shaped cross-section, the cross-section of the T decreasing in dimension from the lower end of the projection to the upper end thereof.

2. An adjustable golf club adapted to reduce the extent of spoilage of off-center hits comprising:

a shaft adjustable as to length and having at the lower end thereof a head adjustably connected thereto, said head comprising a blade having a striking face and a sole extending at an acute angle to said striking face so as to form the leading edge of said blade, the body structure of said blade being of relatively lightweight material,

weight structure of more than twice the density of said body structure positioned to form the opposite ends of said leading edge and to keep the center of mass of the club head close to said striking face, said weight structure providing said club head with a moment of inertia about a vertical axis larger than the normal moment of inertia of a club head of similar size and weight with said weight structure otherwise positioned so as not to form the opposite ends of said leading edge, thereby reducing the club head spin resulting from off-center hits,

means for adjusting the angular position of said striking face relative to said shaft to change the loft of said golf club for different shots, and

wherein said adjustable shaft comprises a shaft section having at the lower end thereof means of attaching said head, the upper end of said shaft section including a very gradually sloping portion and terminating in a threaded portion,

a threaded nut member carried by the threaded end of said shaft section,

a hollow handle section slidably mounted on said shaft section,

said handle section having a cross-section in the shape of a polygon and corresponding to the shape of said nut member which is received therein,

said threaded nut member being so constructed and arranged to be tightened and loosened on said threaded portion of said shaft upon relative rotation between said shaft and handle sections so very gradually as to require relative motion through an angle in the order of 45° or more so as to be able to avoid unintentional loosening of the handle and to be able to absorb the reduced club head spin resulting from off-center hits,

said nut member including a solid portion and integral expandable portions extending axially from said solid portion of said nut member which upon turning of said nut member on said threaded portion of said shaft section causes said expandable portions to move on said sloping portion and so to expand outwardly very gradually against the inner surface of said handle section for frictionally interlocking said handle and shaft sections at a selected overall length.

3. An adjustable shaft for a golf club comprising:

a shaft section having at the lower end thereof means for attachment of a head, the upper end of said shaft section including a very gradually sloping portion and being terminated in a threaded portion,

a threaded nut member carried by said threaded portion of said shaft section,

a hollow handle section slidably mounted on said shaft section, said handle section having a cross-section in the shape of a polygon and corresponding to the shape of said nut member which is received therein,

said threaded nut member being so constructed and arranged to be tightened and loosened on said threaded portion of said shaft upon relative rotation between said shaft and handle sections so very gradually as to require relative motion through an angle in the order of 45° or more so as to be able to avoid unintentional loosening of the handle,

said nut member being slotted axially on each of its sides to form integral expandable leg portions which upon tightening of said nut member on said shaft section causes said leg portions to engage said very gradually sloping portion and thus expand outwardly very gradually against the inner surface of said handle section for frictionally interlocking said handle and shaft sections at a selected overall length.

4. An adjustable shaft for a golf club according to claim 3 wherein said very gradually sloping portion of said shaft section is positioned adjacent said threaded portion thereof.

5. An adjustable shaft for a golf club according to claim 3 wherein said very gradually sloping portion comprises a face of a thread on said threaded portion.

6. An adjustable shaft for a golf club according to claim 4 wherein the outer surfaces of said leg portions are beveled inwardly from an intermediate region thereon toward the free ends of said leg portions whereby a lever action is produced due to engagement of the inner surface of said leg portions at the free ends thereof with said very gradually sloping portion of said shaft and engagement of said outer surfaces of said leg portions adjacent said intermediate region with said inner surface of said handle section.

7. An adjustable shaft for a golf club according to claim 5 wherein said leg portions are located at one end of said nut member and the other end of said nut member includes axially compressible structure, said shaft section adjacent said threaded portion being provided with a shoulder against which said axialy compressible structure of said nut member is adapted to engage during tightening of said nut member on said shaft section.

8. An elongated structure adjustable as to length and suitable as an adjustable shaft for a golf club or the like comprising:

a first section including a very gradually sloping portion and terminating in a threaded portion;

a threaded nut member carried by said threaded portion of said first section,

a hollow second section slidably mounted on said first section, said second section having a cross-section in the shape of a polygon and corresponding to the shape of said nut member which is received therein,

said threaded nut member being so constructed and arranged to be tightened and loosened on said threaded portion of said shaft upon relative rotation between said first and second sections so very gradually as to require relative motion through an angle in the order of 45° or more so as to be able to avoid unintentional loosening of the sections,

said nut member being slotted axially on each of its sides to form expandable leg portions which upon tightening of said nut member on said first section causes said leg portions to engage said very gradually sloping portion and thus expand outwardly very gradually against the inner surface of said second section for frictionaly interlocking said first and second sections at a selected overall length.

9. An elongated structure adjustable as to length according to claim 8 wherein said sloping portion of said first section is positioned adjacent said threaded portion thereof.

10. An elongated structure adjustable as to length according to claim 8 wherein said leg portions are located on one end of said nut member and the other end of said nut member includes axially compressible structure, said first section adjacent said threaded portion being provided with a shoulder against which said axially compressible structure of said nut member is adapted to engage during tightening of said nut member on said first section.

11. A golf club head adapted to reduce the extent of spoilage of off-center hits comprising:

a blade having a striking face and a sole extending at an acute angle to said striking face so as to form the leading edge of said blade,

the body structure of said blade being of relatively light weight material,

weight structure having a density at least twice the density of said body structure positioned to form the opposite ends of said leading edge and to keep the center of mass of the club head close to said striking face,

said weight structure providing the club head with a moment of inertia about a vertical axis larger than the moment of inertia of a club head of similar size and weight with said weight structure otherwise positioned,

said body structure and said weight structure having complementary configurations along their mating surfaces to provide interlocking engagement,

said complementary configurations being so constructed and arranged as to prevent all relative movement between said structure other than movement parallel to said leading edge,

means on one of said structures and engageable with the other of said structures for limiting relative longitudinal movement between said structures parallel to said leading edge, and

an elongated projection extending above said striking face a distance greater than the diameter of a conventional golf ball for the exclusive purpose of providing said club head with a moment of inertia about a horizontal axis larger than the normal moment of inertia of said blade in the absence of said projection.

12. A golf club head according to claim 11 wherein said weight structure includes terminal portions extending beyond said body structure at the heel and toe of said head, and said last-named means comprises stop structure carried by said terminal portions of said weight structure and projecting above said mating surfaces.

13. A golf club head according to claim 11 wherein said weight structure comprises:

a single member of uniform density.

14. A golf club head according to claim 11 wherein said weight structure comprises:

a three-layer sandwich,

the two outer layers of which comprise terminal portions of said weight structure which extend beyond said body structure at the heel and toe of said head, both of said terminal portions having the same density, and which density is greater than the density of the center layer of said sandwich.

15. A golf club head according to claim 14 wherein said center layer of said sandwich has a length substantially coextensive with the length of said body structure.

16. A golf club head according to claim 14 wherein said center layer of said sandwich has a length substantially less than the length of said body structure along said mating surfaces.

17. A golf club head adapted to reduce the extent of spoilage of off-center hits comprising:

a blade having a striking face and a sole extending at an acute angle to said striking face so as to form the leading edge of said blade,

the body structure of said blade being of relatively lightweight material,

weight structure of more than twice the density of said body structure positioned to form the opposite ends of said leading edge and to keep the center of mass of the club head close to said striking face,

said weight structure providing the club head with a moment of inertia about a vertical axis larger than the moment of inertia of a club head of similar size and weight with said weight structure otherwise positioned, and

said body structure having a narrow elongated projection intermediate the ends of said striking face and extending above said striking face a distance greater than the diameter of a conventional golf ball and extending a total distance from said leading edge greater than two diameters of a conventional golf ball, for the exclusive purpose of providing the club head with a moment of inertia about a horizontal axis larger than the normal moment of inertia of the club head in the absence of said projection whereby said larger moments of inertia provided by said weight structure and said projection cooperate in reducing loss of ball velocity from hits off-center with respect to the center of mass of the club head.

18. A golf club head according to claim 17 wherein said elongated projection is inclined towards the heel of said club head.

19. A golf club head according to claim 17 wherein said elongated projection is in the same plane as said striking face.

20. A golf club head according to claim 17 wherein said elongated projection extends above said striking face tapering from a relatively wide base at the upper edge of said striking face to a relatively pointed upper end.

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