Fig. 1.

Fig. 2.

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To all whom it may concern:

Be it known that I, IRVING R. PRENTISS, a citizen of the United States, residing at Philadelphia, county of Philadelphia, State of Pennsylvania, have invented certain new and useful Improvements in Sets of Golf Clubs, of which the following is a specification.

My invention relates to golf clubs and particularly to a set of golf clubs the individual clubs of which are relatively proportioned as to certain definite physical characteristics in a manner to adapt them to the player.

An object of my invention is to provide a set of clubs each of which the player will handle with the same facility and in each of which he will repose the same confidence.

A further object of my invention is to provide a set of clubs which will greatly reduce the time necessary for a beginner to acquire a reasonably high degree of proficiency in the game and which will enable the most expert player to reduce his average score below that possible even with clubs collected during many years of playing and selected with careful attention to the results obtained.

A further object of my invention is to provide a set of clubs which will permit such a uniformity in the position of the player when addressing the ball, and such a uniformity in the manner of making the stroke, that practice with any club will make the player more proficient, not only in the use of that club, but also in the use of every other club of the set.

According to my invention the clubs of a set are relatively proportioned so that each club is adapted to the needs of the player, as distinguished from present practice according to which the player by a long course of training and practice is taught to accommodate himself to the peculiar requirements of the individual clubs of the set. The time and expense necessary to acquire a set of clubs each of which is best suited to the requirements of the individual player is thus greatly reduced.

Prior to my invention, golf clubs have been manufactured and grouped into sets indiscriminately with no regard to or understanding of certain physical characteristics of the clubs which must be properly proportioned if the player is consistently to play each club equally well. Clubs have been selected by holding them in the hands and swinging them in an effort to determine whether they “feel” alike, but inasmuch as the various clubs of a set differ not only in weight and length, but also in the distribution of the weight, this method of selecting clubs is of little practical utility. Examinations which I have made of a great number of sets of clubs, including the clubs of a number of the most celebrated players in the world, reveals the presence, in each set, of clubs which depart widely from other clubs of the set in those physical characteristics which I have found to be essential to the establishment of such a cooperative relationship as will enable the player consistently to use each club with substantially the same degree of success and confidence. In many cases I have adjusted such clubs in accordance with the principles of my invention and in every case there has been such a reduction in the average score of the player as might have been anticipated. In the case of the expert player the reduction in the actual number of strokes is of course not great, but in the case of the player who has acquired only a moderate degree of proficiency and who has not therefore learned to adapt himself to the peculiarities of each of his clubs, the reduction in the average score is very considerable and the improvement of the player surprisingly rapid.

According to the principles of my invention, not only can clubs of various weights and lengths be properly relatively proportioned, but any given club can be accurately duplicated. A player is thus enabled to provide himself with as many duplicate clubs
or sets of clubs as will insure against the loss of an important match by reason of the breaking of a favorite club or loss of a set of clubs.

My invention will be better understood from the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

In the drawing, Fig. 1 is a diagrammatic representation of a golf club and Fig. 2 is a curve sheet.

Referring to Fig. 1, L represents the length of a golf club which is measured from the heel of the club to the end of the handle.

B represents what I call the balance of the club, which is determined by balancing the club upon a knife-edge indicated diagrammatically at L.

I have discovered that the characteristics of a club which adapt it to the player depend not only upon the weight and length of the club but upon the distribution of the total weight throughout the club, which distribution is determined by the balance of the club. A club which is too heavy may be made to "feel" lighter by shifting the balance point toward the grip. This reduces the radius of gyration and lessens the effort required to swing the club. It will be apparent that the balance point may be shifted by applying weight either to the head or to the grip end of the club, or by removing weight from either end. The balance point may also be changed while maintaining the total weight of the club constant by removing weight from one end and applying it to the other. Since the balance point of the club is nearer the head than the grip, it is apparent that a given weight added to the head will not cause as great a shift of the balance point as an equal weight applied to the grip. Likewise, a weight applied to the end of the grip will have a greater effect than the same weight, for example, applied to the middle of the grip.

According to my invention a uniform relationship is established between length and weight and also between length and balance. The uniform relationship between length and weight is of great importance since it enables one to determine at once the proper weight for a club of given length and also makes it possible to establish a uniform relationship between the weights and the balances of the clubs as well as between the lengths and balances.

I have discovered that, in order to establish the proper relationship between the clubs to adapt them to the player, the weight should vary regularly with the length and preferably the weight-length product of any club should be substantially the same as the weight-length product of every other club.

This relationship is expressed by the following equation:

\[ LW = C \]

where \( L \) represents the length of the club, \( W \) the total weight of the club and \( C \) a constant.

It will nearly always be found that a player will have one club in his set of which he is particularly fond and in which he reposes the greatest confidence for the reason that he can consistently play that club successfully. According to one method in which I apply my invention, this club is taken as the base club and the physical characteristics of the other clubs are adjusted to this club as a standard so that all of the clubs may be played with the same facility as the base club.

If, for example, this club is a driver 43" long, weighing 12.8 ounces and with a balance of 14", the weight-length product \( C \) of equation (1) becomes approximately 550 inch ounces. To determine the weight of any club of a different length it is merely necessary to divide this product 550 by the new club length.

Referring to Fig. 2, the curve A is plotted according to the formula \( LW = 550 \). The ordinates of this curve are represented in inches of length and the abscissas in ounces.

It will be observed that the curve A indicates that a club 43" long should weigh 12.8 ounces and that a club, for example, 36" long should weigh approximately 13.25 ounces. It will be apparent that the equation of the curve A is that of a hyperbola referred to its asymptotes.

If a club, having a weight and length such that the product \( LW \) is different from 550, is chosen as the standard club, the curve A will be displaced. If, for example, the player's favorite club were a mashie 36" long, weighing 14 ounces and having a balance of 15", the product of the length and weight would be 504 inch ounces and the equation of the new curve, which is represented in the drawing at \( A' \), would be \( LW = 504 \).

It will be observed that throughout the range of the curve, which is represented by the lengths of clubs used in ordinary practice, the curve A does not change appreciably in shape. It is, therefore, possible to use the same sheet of co-ordinates for determining with a sufficient degree of accuracy the desired curve for any base club by merely drawing a new curve parallel to the first curve passing through the point representing the weight and length of the new base club. To facilitate the use of the curve sheet, a jig may be used cut on one side according to the curve A and by placing this jig at the proper place to make the curve pass through the point corresponding to the new base club, the weight of clubs of dif-
different lengths may be at once determined. If greater accuracy is desired the positions of two or more points of the new curve at a considerable distance apart may be determined from the formula and the curve then completed by the jig.

Having determined the weights of the various clubs of the set according to the weight-length or inch-ounce rule, which I have described, I then adjust the balance of the respective clubs so that they also will vary regularly with the club length in accordance with a predetermined law. I have discovered that the proper relationship is expressed by the following equation:

\[(2) \quad \frac{L^2}{L_i^2} \times B_i = B\]

In this formula \(L_i\) and \(B_i\) represent the length and balance respectively of the base club, while \(L\) and \(B\) respectively represent the length and balance of the club which is to be adjusted in accordance with the base club.

From equation (2) it is seen that:

\[(3) \quad \frac{L^2}{L_i^2} = \frac{B}{B_i}\]

From equation (3) it will be seen that the balances of the clubs are to each other as the squares of the lengths. Where the weight-length product is constant the weights vary inversely with the lengths and equation (3) may therefore be written:

\[(4) \quad \frac{W^2}{W_i^2} = \frac{B}{B_i}\]

This means that the balances are to each other inversely as the squares of the weights.

It is also apparent that equation (3) may be put into the following form:

\[(5) \quad \frac{LW_i}{L_iW} = \frac{B}{B_i}\]

This means that the balances are to each other as the product of the length of the first by the weight of the second is to the product of the length of the second by the weight of the first.

Assuming that the base club has a length of 43" and a balance of 14", equation (2) becomes:

\[(6) \quad \frac{L^2}{43^2} \times 14 = B\]

If the new club has a length of 36.8 inches, the balance \(B\) will be found to be 10". In order to enable the clubs to be readily calculated, a curve may be drawn representing the relationship between the length and balance, and such a curve is shown at \(B\) in Fig. 2. This curve being calculated on the basis of a 43" club having a balance of 14".

While this curve may be calculated point by point, it will be observed that equation (2) may be transformed into the following form:

\[(6) \quad L = \sqrt[2]{\frac{B}{L_i^2}}\]

Upon substituting the value 43 for \(L_i\) and the value of 14 for \(B_i\), this equation becomes:

\[(7) \quad L = \sqrt[132B]{3}\]

From equation (7) curve \(B\) may be readily plotted by substituting different values for \(B\) and determining values for \(L\). It will be observed that equation (7) is the equation of a parabola. From the curve \(B\) the proper balance for any length of club may be at once determined.

If the standard club has a different length and balance, the curve \(B\) becomes slightly displaced. If, for example, the player's favorite club were 36" long and had a balance of 10", equation (6) would become:

\[(8) \quad L = \sqrt[129.6B]{3}\]

This curve is represented in dotted lines in Fig. 2 by the curve \(B_i\). It will be observed that throughout the range which is used curve \(B_i\) does not differ appreciably in shape from curve \(B\) and that, therefore, a jig may be used for drawing the curve \(B\) in different positions, as was described in connection with the use of a jig for drawing the curve \(A\) in different positions.

It will be observed that according to this method in which I apply my invention, I first establish uniformity between the clubs based upon the characteristics of the base club by adjusting each of the clubs to the same inch-ounce factor. While I have found a constant inch-ounce factor to be the best relationship to establish between the length and weight of the clubs, my invention, in its broadest aspects, is not limited to such hyperbolic relationship since I believe I am the first to conceive the idea of having the length vary regularly with the weight according to a predetermined relationship. In the examination of the various sets of clubs to which I have heretofore referred, I have always found a number of clubs in each set which departed widely from the desired relationship, showing that no fixed relationship exists between the length and weight of 129 clubs selected by the methods used prior to my invention. In fact, as I have stated, the desirability of such a relationship has heretofore never been conceived. The examination of the sets of clubs of expert 125 players referred to shows that where the club is heavier than it should be the balance of the club is greater than that necessary.
to establish a uniform relationship between the balances and lengths of the various clubs. The same condition of facts exists where clubs are lighter than they should be.

While good scores may be made with clubs which are thus compensated, long practice is nevertheless required to enable the player to develop the skill necessary to adapt himself to the clubs, and in observations which I have made of many expert players, I have found that poor strokes are more frequently made with the improperly weighted and balanced clubs than are made with the clubs which follow more nearly the correct relationship.

Experimental determinations which I have made of the moments of inertia of clubs adjusted according to the principles of my invention indicate that the moment of inertia of any club about a center in the line of the shaft extended, several inches from the end of the club, is the same as the moment of inertia of any other club about a center an equal distance from the end of such club.

In the foregoing it has been assumed that the set of clubs has been constructed from a standard or base club which a player has found by experience to be the one with which he is most skillful. This will be the way in which my invention will be applied where the player is equipped with a set, or part of a set, of clubs and has had sufficient practice to find out which is his "pet" club.

My invention has, however, a broader scope of applicability since its utility is not conditioned upon any knowledge of the game on the part of the person about to acquire a set of clubs. This will more clearly appear when it is borne in mind that by constant practice with one club a player may become very expert in its use. It is possible, therefore, for a player to make any one of a considerable number of clubs having different characteristics his pet club by continuing to practice with that club alone. A beginner may therefore have his choice of any one of a considerable number of sets of clubs made up by the manufacturer or dealer, each set differently constructed in respect to the characteristics above defined, and he may by practice attain a very high degree of proficiency, since, by reason of the constancy of the physical characteristics throughout a set of clubs constructed in accordance with my invention, practice with one club adds to the knowledge required for the use of any of the other clubs of the set. The proficiency attainable by the use of a set of clubs constructed in accordance with my invention is greater than that possible with a set of clubs not so constructed, for the reason that the player is in effect playing with the same club continually and is not called upon to adapt himself to the use successively of clubs having different physical characteristics.

What I claim as new and desire to secure by Letters Patent of the United States is,—

1. A set of golf clubs comprising clubs of various weights and lengths characterized by the fact that the weight-length product of each of the clubs is substantially the same.

2. A set of golf clubs including a plurality of clubs of various weights and lengths, characterized by the fact that the balances of said plurality of clubs are to each other substantially inversely as the squares of their weights.

3. A set of golf clubs including a plurality of clubs of various weights and lengths, characterized by the fact that the balances of said plurality of clubs are to each other substantially as the squares of their lengths.

4. A set of golf clubs including a plurality of clubs of various weights and lengths, characterized by the fact that the balance of one of said plurality of clubs is to the balance of another of them substantially as the product of the length of the first by the weight of the second is to the product of the length of the second by the weight of the first.

5. A set of golf clubs including a plurality of clubs of various weights and lengths, characterized by the fact that the length-weight product of each of said plurality of clubs is substantially the same, and by the fact that the balances of any two of said plurality of clubs are to each other substantially as the squares of the lengths of said two clubs.

6. A set of golf clubs consisting of clubs of various weights and lengths, characterized by the fact that the length-weight product of each of the clubs is substantially the same, and by the fact that the balances of said clubs are to each other substantially as the squares of their lengths.

7. A set of golf clubs including a plurality of clubs of various weights and lengths, characterized by the fact that said plurality of clubs are relatively proportioned as to length and weight so that the weight varies regularly with the length substantially in accordance with a predetermined relation.

8. A set of golf clubs including a plurality of clubs of various weights and lengths, characterized by the fact that said plurality of clubs are relatively proportioned as to length, weight and balance so that the weight varies regularly with the length substantially in accordance with a predetermined relation, and so that the balance varies regularly with the length substantially in accordance with a predetermined relation.
9. A set of golf clubs comprising clubs of various weights and lengths characterized by the fact that the weight, length and balance of the clubs are so proportioned that the moment of inertia of any club about a center near the end of the club in the line of the shaft extended is substantially equal to the moment of inertia of any other club about a center an equal distance from the end of such club.

10. A set of golf clubs including a plurality of clubs of different weights and lengths characterized by the fact that said plurality of clubs are relatively proportioned as to length and balance so that the length varies regularly with the balance substantially in accordance with a predetermined relation.

In witness whereof, I have hereunto set my hand this 16th day of April, 1921.

IRVING R. PRENTISS.