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US 5496028 A

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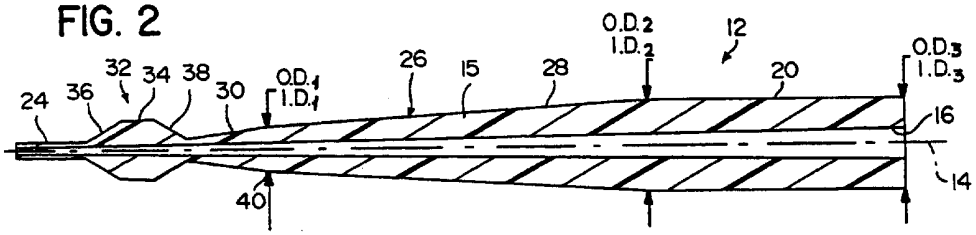
(54) Golf club shaft

(57) A fibre-reinforced plastic golf club shaft 12 includes a bulge 32 near the inboard extremity of the tip end. The bulge is formed with a central cylindrical section 34 and transition sections 36 and 38 and has an axial opening whose diameter is less than the diameter of the immediately adjacent portions of the shaft.

FIG. 2



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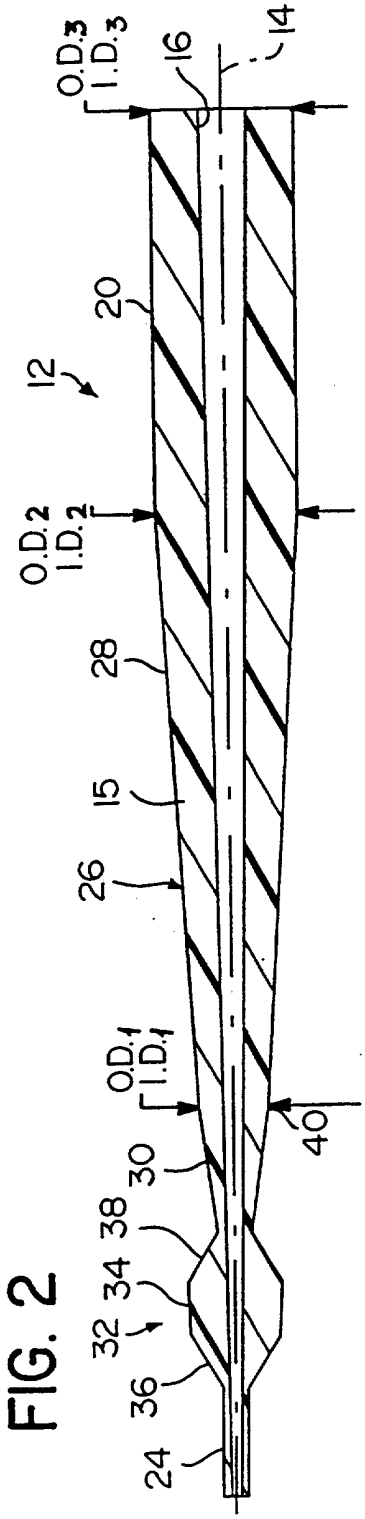
O.D.3
I.D.3
16
14
20
12
O.D.2
I.D.2
28
15
26
O.D.1
I.D.1
40
30
38
34
32
36
24

FIG. 2

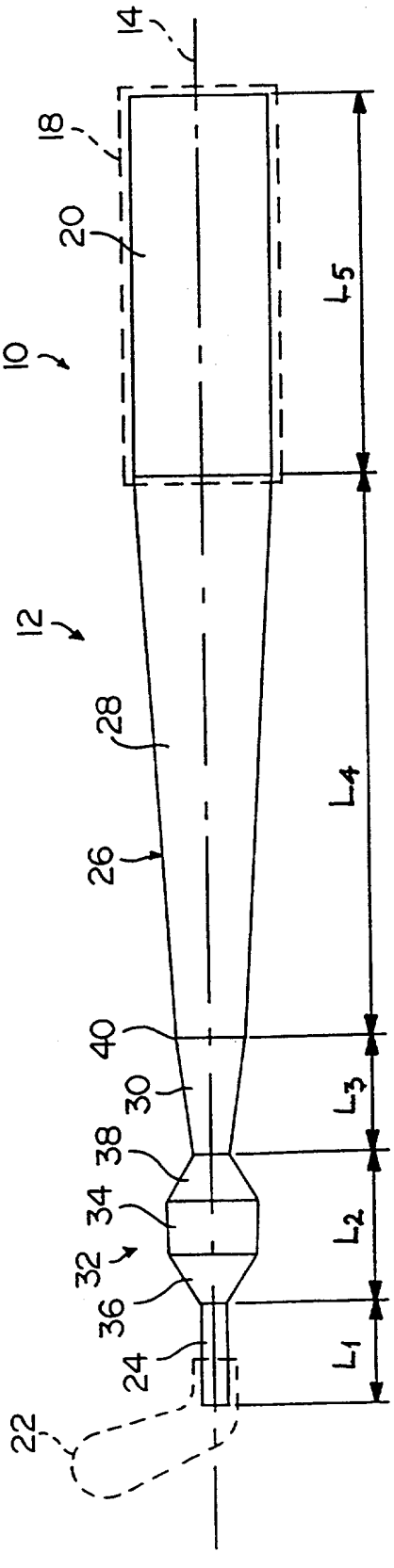
14
18
20
10
12
28
26
40
30
38
34
32
36
24
22
L5
L4
L3
L2
L1

FIG. 1

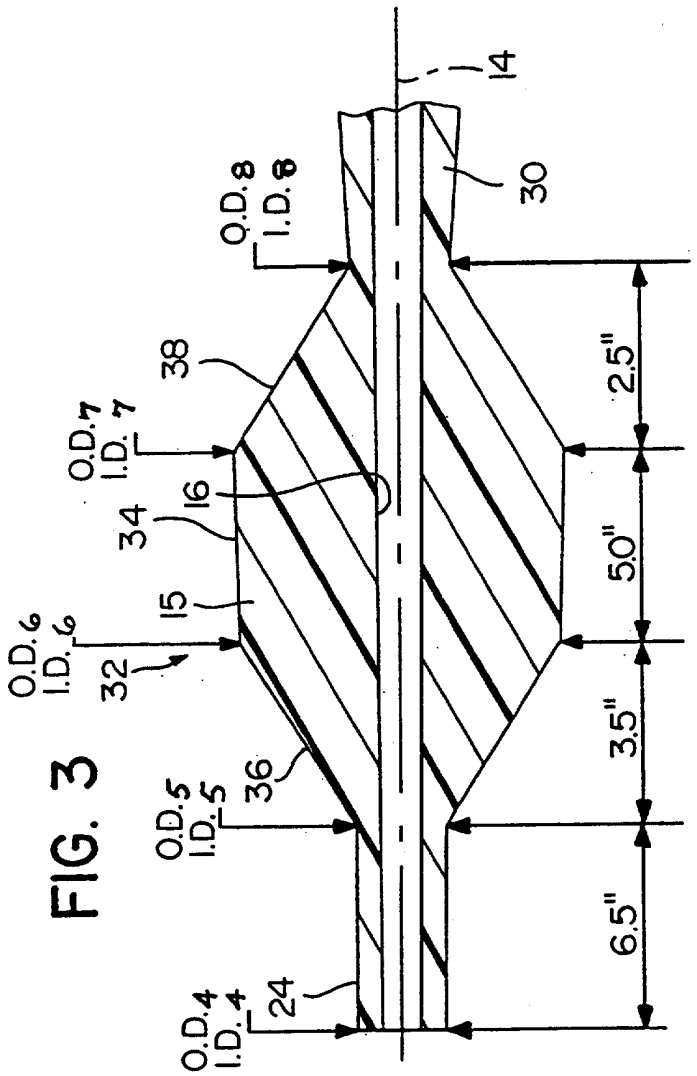
14
30
O.D.8
I.D.8
38
O.D.7
I.D.7
16
34
15
O.D.6
I.D.6
32
36
O.D.5
I.D.5
24
O.D.4
I.D.4
2.5"
5.0"
3.5"
6.5"

FIG. 3

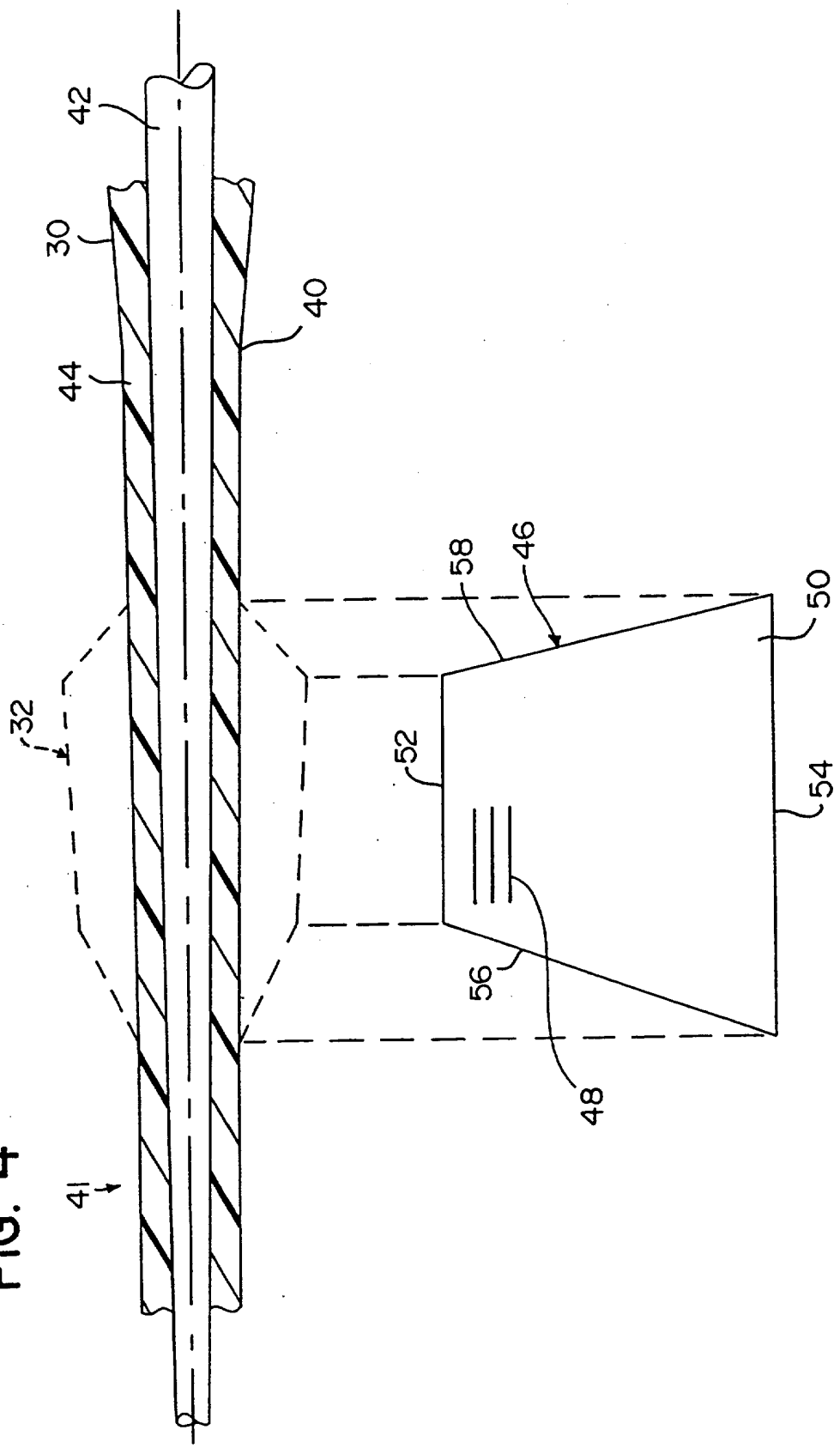

FIG. 4

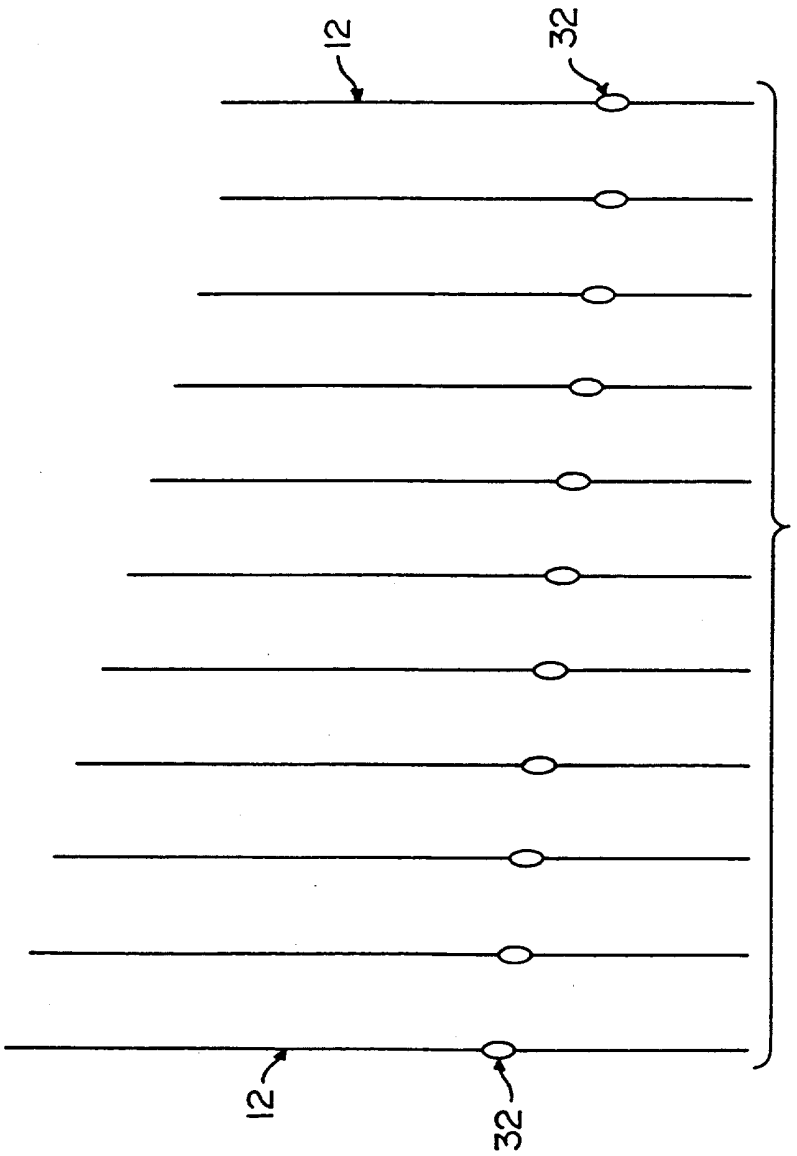

FIG. 5

GOLF CLUB AND SHAFT THEREFOR

This invention relates to a golf club and a shaft therefor and particularly relates to a golf club and a shaft therefor having structure which increases the opportunity for making clubs of lighter weight with enhanced flexibility and torsional characteristics.

Golfing is a world wide sport with increasing popularity. With the increase in the golfing population, there is a significant increase in the number of players with a discerning demand for golf clubs which will improve and enhance their playing of the game. This demand goes well beyond those who play professionally and those in the upper levels of the amateurs.

Typically, some of the aspects of concern for the discerning golfer are the weight of the club, a balance between the flexibility and the stiffness of the shaft, and the torsional character of the shaft. Golfers usually prefer a light-weight club for obvious reasons. However, the flexibility and torsional requirements vary amongst golfers and relate to the golfer's "feel" of the club when the club is swung and upon impact with the ball.

In an effort to provide golf clubs which generally address the concerns noted above, many designs of shaft configuration and composition have evolved over the years. Some of these designs involve the placement of an enlargement in a selected portion of the shaft to, in effect, divide the shaft into two sections. One example of this premise regarding metal shafts is disclosed in U.S. Patent No. 2,050,554 which issued on August 11, 1936. An example of such structure in a composite or non-metallic

shaft is disclosed in United Kingdom Patent No. GB 2,250,443 which issued on August 24, 1994.

While golf clubs having shafts with a variety of such enlargement designs have been effective, there is a continuing demand and need for further improvement in this aspect of shaft design.

In addition, each club within a set of clubs typically has parameters which are different from the parameters of the other clubs in the set. For example, the club length, club weight, head configuration and other club parameters of each of the clubs of a set is different from the same parameters of the other clubs in the set. This equates to a different moment of inertia and different torsional requirement for each club with respect to each of the other clubs of the set. Therefore, each time the golfer uses a different club from the set in the normal playing of the game of golf, the golfer experiences different reactions from the swinging of the various clubs of the set which could affect the consistency in the golfer's playing of the game.

In view of this potential inconsistency, there is a need to balance or match the clubs of a set so that torsional stability of each club is normalised with respect to the other clubs of the set and the reaction realised by the golfer is somewhat consistent from club to club of the set.

It is, therefore, an object of this invention to provide a golf club, and a shaft therefor, with improved characteristics leading to enhanced playing of the game of golf by the users of a club employing such a shaft.

It is a further object of this invention to provide a golf club shaft which is sectionalised to enhance performance characteristics of a golf club which employs such a shaft.

It is another object of this invention to provide a shaft which is adaptable for use with the different clubs of a set to provide general uniformity and matching in the torsional characteristics of the different clubs and thereby enhance a golfers opportunity to play the game of golf within the normal ability of the golfer.

The present invention provides a golf club shaft, which comprises:

a body composed of a non-metallic material extending longitudinally along an axis thereof;

the body formed with a butt end formed at one end thereof having an inboard extremity of a prescribed diameter and an outboard extremity;

the body formed with a tip end formed at an end of the body axially opposite the butt end and spaced axially therefrom and having an outboard extremity and having an inboard extremity of a diameter less than the prescribed diameter;

the body formed with an intermediate section which extends from the inboard extremity of the butt end toward the tip end wherein the diameter of an end of the intermediate section which joins the butt end is the same as the prescribed diameter and the diameter at an opposite end of the intermediate section is less than the prescribed diameter;

the body formed with a bulge along the axis of the body;

portions of the body immediately adjacent the bulge formed by the non-metallic material extending outward from a

location in the immediate vicinity of the axis for a first prescribed distance from the axis to an outer surface of the portions of the body; and

the bulge formed by the non-metallic material extending outward from a location closer to the axis than the outer surface of the immediately adjacent portions of the body for a second prescribed distance, greater than the first prescribed distance, from the axis to an outer surface of the bulge.

The present invention further provides a golf club which embodies the shaft described above in combination with a grip assembled on the butt end of the shaft and a club head assembled on the tip end of the shaft.

An embodiment of a golf club according to the present invention will now be described, with reference to the accompanying drawings, in which:

Figure 1 is a side view showing a golf club including a shaft with a bulge;

Figure 2 is a sectional view showing the shaft of Figure 1 and the bulge;

Figure 3 is a sectional view showing the bulge of Figures 1 and 2;

Figure 4 is a diagrammatical view showing one technique for forming the bulge of Figure 1; and

Figure 5 is a diagram showing representations of the shafts of a set of golf clubs with the shaft of each club having a bulge formed thereof to match the clubs of the set for consistent torsional performance.

As shown in Figure 1, a golf club 10 includes a shaft 12 which is formed in a configuration of a hollow body or tube having a longitudinal axis 14 and composed of a composite material 15 (Figures 2 and 3) which includes

non-metallic fibres carried in a cured plastic matrix. The shaft 12 is formed with an axial opening 16 (Figure 2) therethrough. The club 10 further includes a grip 18, shown in phantom, assembled on a cylindrical butt end 20 of the shaft 12 and a club head 22, shown in phantom, mounted on a cylindrical tip end 24 of the shaft. The shaft 12 is also formed with an intermediate section 26 between the butt end 20 and the tip end 24. It is noted that the exterior surfaces of the butt end 20 and the tip end 24 are preferably cylindrical as illustrated, but either or both ends could be tapered without departing from the spirit and scope of the invention. The intermediate section 26 of the shaft 12 is composed of two segments 28 and 30 which extend along the axis 14.

In the preferred embodiment of the invention as shown in Figures 1 and 2, a bulge 32 is formed in the shaft 12 and is located between, and joined to, the segment 30 at one axial end of the bulge and to the tip end 24 at the opposite axial end of the bulge. Referring to Figures 1, 2 and 3, the bulge 32 is formed with a central cylindrical section 34 and two transitional sections 36 and 38 each of which are joined at one axial end thereof to the central section and to an opposite axial end to the segment 30 and the tip end 24, respectively.

The length, outside diameter (O.D.) and inside diameter (I.D.) dimensions and the structural configurations of the shaft 12, and the axial location of the bulge 32, of Figures 1, 2 and 3 as shown in the table below depict the preferred embodiment of the invention. Other length and diameter dimensions and structural configurations of the shaft 12, and axial locations of the bulge 32, can be used without departing from the spirit and scope of the invention.

Also in the preferred embodiment, the shaft 12 is composed of non-metallic fibres, such as graphite fibres, and a cured plastic matrix, such as a cured epoxy resin which carries the fibres therein. The fibres could be formed from fibreglass, aramid, boron or other suitable non-metallic fibre materials, and the epoxy resin matrix could be polyester, vinyl ester, nylon or any other suitable thermoset or thermoplastic matrix.

Further, in the preferred embodiment, the axial opening 16 is formed with a wall which is straight and uniformly tapered as illustrated in Figure 2. As further shown in Figure 2, and as noted above, the exterior surface of the butt end 20 and the tip end 24 are cylindrical in shape and the segment 28 is formed at a first uniform taper and the segment 30 is formed at a second uniform taper. Segments 28 and 30 are joined at a juncture 40 along the intermediate section 26 at the prescribed location as indicated by the length dimensions in Figure 1. It is noted that the intermediate section 26 of the shaft 12 could be formed with a uniform taper between the inboard extremities of the butt end 20 and the bulge 32, rather than with the segments 28 and 30, without departing from the spirit and scope of the invention. The dimensions shown in Figures 1 to 3 and listed in the table below show the various locations of the portions of the shaft 12 relative to each other. These dimensions could be varied without departing from the spirit and scope of the invention.

Figure 1		
	cm	Inches
L_1	16.51	6.5
L_2	27.94	11
L_3	5.08	2
L_4	39.37	15.5
L_5	12.7	5
Figure 2		
OD_1	1.16	0.46
ID_1	0.76	0.3
OD_2	1.52	0.6
ID_2	1.23	0.49
OD_3	1.52	0.6
ID_3	1.24	0.49
Figure 3		
L_1	16.51	6.5
$L_{2.1}$	8.89	3.5
$L_{2.2}$	12.7	5
$L_{2.3}$	6.35	2.5
OD_4	0.94	0.37
ID_4	0.52	0.2
OD_5	0.94	0.37
ID_5	0.52	0.2
OD_6	1.03	0.4
ID_6	0.54	0.21

	cm	Inches
OD_7	1.05	0.41
ID_7	0.6	0.24
OD_8	0.95	0.38
ID_8	0.68	0.27

Referring to Figure 3, the structural configuration of the preferred embodiment of the bulge 32 is depicted by the various dimensions as shown in the table above. Further, the bulge 32 is composed of the composite material 15 which extends radially outward from the wall of the axial opening 16 in the preferred embodiment of the invention. The contour of the bulge 32 follows the prescribed tapers of the transitional sections 36 and 38 at opposite ends thereof and the generally cylindrical exterior of the central section 34. Thus, except for the axial opening 16, the composite material 15 of the bulge 32 in the preferred embodiment of the invention occupies the entire volume defined between the wall of the axial opening and the exterior contour of the bulge.

The particular arrangement of the elements of the bulge 32 provide structural features of the shaft 12 which enhance the performance characteristics of the shaft when the shaft forms a portion of the golf club 10. By placement of the bulge 32 as illustrated in Figure 1, the centre of gravity of the club 10 is located closer to the tip end 24 of the shaft 12 than it would normally be in a bulgeless shaft. This feature permits the use of lighter weight club heads in the assembly of a finished golf club.

Referring to Figure 4, in one technique for making the shaft 12, a subassembly 41 is formed by wrapping a plurality of sheets (not shown) of composite material around a mandrel

42 to form a composite pack 44 of the composite material on the mandrel. Each sheet of composite material includes a plurality of non-metallic fibres, such as graphite fibres, carried in an uncured plastic matrix, such an epoxy resin matrix. The fibres are spaced, parallel and are arranged in any of several conventional orientation patterns in a manner well known in the manufacture of composite shafts. Thereafter, a sheet 46 of the composite material, composed of fibres 48 carried in an uncured plastic matrix 50, is formed in the configuration illustrated in Figure 4. As shown, the sheet 46 is formed with a shorter end 52 spaced from a longer opposite end 54 and tapered sides 56 and 58. Also, the fibres 48 are spaced and parallel with respect to each other and are parallel with the ends 52 and 54 of the sheet 46, and extend between the sides 56 and 58 thereof. It is noted that other shapes of the sheet 46, and other orientations of the fibres 48 could be employed to form a bulge without departing from the spirit and scope of the invention.

The sheet 46 is then wrapped around the subassembly 41 to form the wrapping which will eventually form the bulge 32, the outline of which is represented in Figure 4 in dotted lines. Thereafter, a heat shrinkable film (not shown) is wrapped around the subassembly 41 and the assembled sheet 46 to form an assembly. In the assembly, the sheets of composite material, including the sheet 46, are compactly captured between the mandrel 42 and the heat shrinkable film. The assembly is then placed in a heated environment whereby the uncured plastic matrix of each sheet liquefies and blends generally with the plastic of the other sheets while the various fibres maintain generally their assembled orientation. Also, the heat shrinkable film shrinks to confine the captured composite material to a desired shape. The assembly is removed from the heated

environment and is cooled whereby the blended plastic is cured in a solid form. The heat shrinkable film is removed and the mandrel 42 is separated axially from the cured product to reveal the shaft 12 which may be processed through external sizing and surface finishing operations.

As shown in Figure 5, the presence and selective arrangement of the elements of the bulge 32 in a set of shafts 12 assist in the performance optimisation of the individual clubs within the related set of golf clubs. In a matched set of golf clubs, each head exhibits unique dynamic characteristics. The moment of inertia and, consequently, the torsional requirements of each head within the set are different from each other. The bulge 32 and its positioning on the shaft 12 serve to address the torsional requirement of each head and normalise the torsional stability of each individual club within the set. This results in the matching of each club within the set from a torsional standpoint.

The presence of the bulge 32 in the shaft 12 serves to segment the shaft from a flexural standpoint. The bulge 32 allows different combinations of flexural stiffness in the portions of the shaft 12 between the bulge and the butt end 20 on the one side, and the bulge and the tip end 24 on the other side. The combining of different flexural stiffnesses with the shaft 12 contributes to a particular golf shot trajectory, depending on the combination used. For example, if the shaft 12 is designed with both of the above-noted portions being flexible, the resultant golf shot trajectory would be higher than if the shaft was designed with both portions being fairly stiff or rigid. In accordance with the principles of this invention, the bulge 32 allows several permutations of this concept in order to optimise

both the golf ball launch angle when struck with the golf club 10 and the resultant trajectory of the golf ball.

It is noted that, in the drawings, some of the structural features have been drawn out of proportion for illustration purposes only. Actual structural configurations can be readily determined by virtue of the dimensions shown in the table in the text.

CLAIMS

1 A golf club shaft 12, which comprises:

a body composed of a non-metallic material 15 extending longitudinally along an axis 14 thereof;

the body formed with a butt end 20 formed at one end thereof having an inboard extremity of a prescribed diameter and an outboard extremity;

the body formed with a tip end 24 formed at an end of the body axially opposite the butt end 20 and spaced axially therefrom and having an outboard extremity and having an inboard extremity of a diameter less than the prescribed diameter;

the body formed with an intermediate section 26 which extends from the inboard extremity of the butt end 20 toward the tip end 24 wherein the diameter of an end of the intermediate section which joins the butt end is the same as the prescribed diameter and the diameter at an opposite end of the intermediate section 26 is less than the prescribed diameter;

the body formed with a bulge 32 along the axis of the body;

portions of the body immediately adjacent the bulge 32 formed by the non-metallic material 15 extending outward from a location in the immediate vicinity of the axis 14 for a first prescribed distance from the axis 14 to an outer surface of the portions of the body; and

the bulge 32 formed by the non-metallic material 15 extending outward from a location closer to the axis 14 than the outer surface of the immediately adjacent portions of the body for a second prescribed distance, greater than the first prescribed distance, from the axis 14 to an outer surface of the bulge 32.

2 A golf club shaft according to claim 1, characterised in that the bulge 32 is formed with a central section 34, a first transition section 36 and a second transition section 38 with the first transition section 36 joined between one end of the central section 34 and the portion of the body immediately adjacent the first transition section 36 and the second transition section 38 joined between an opposite end of the central section 34 and the portion of the body immediately adjacent the second transition section 38.

3 A golf club shaft according to claim 2, characterised in that each of the first and second transition sections 36,38 are formed with exterior surfaces which are tapered outward from their respective juncture with the portion of the body to their juncture with the central section 34.

4 A golf club shaft according to claim 2, characterised in that the central section 34 is formed with an exterior surface in a generally cylindrical shape.

5 A golf club shaft according to claim 2, characterised in that the first transition section 36 is closer to the tip end 24 of the body, and of an axial length greater than the axial length of the second transition section 38.

6 A golf club shaft according to claim 1, characterised in that the bulge 32 is formed with an axial opening 16 therethrough having a wall which is circular at any transaxial section thereof and which is straight from an inboard end of the bulge 32 to an outboard end thereof.

7 A golf club shaft according to claim 1, characterised in that the bulge 32 is formed in the tip end 24.

8 A golf club shaft according to claim 1, characterised in that the bulge 32 is formed in the intermediate section 26.

9 A golf club shaft according to claim 1, characterised in that the bulge 32 is formed partially in the tip end 24 and partially in the intermediate section 26.

10 A golf club shaft according to claim 2, characterised in that the central section 34 extends radially from the axis 14 of the body by a distance which is greater than the diameter of the portions of the body immediately adjacent the bulge 32.

11 A golf club shaft according to claim 6, characterised in that the opening 16 formed axially through the bulge 32 is tapered inward toward the axis 14 of the body from the inboard end to an outboard end of the bulge 32.

12 A golf club shaft according to claim 6, characterised in that the diameter of the opening 16 of the bulge 32 is less than the diameter of any external portion of the body immediately adjacent the bulge 32.

13 A golf club shaft according to claim 1, characterised in that the bulge 32 is formed by a composite material 15 including non-metallic fibres and a cured plastic matrix.

14 A golf club shaft according to claim 11, characterised in that the composite material 15 of the bulge 32 extends radially from the opening 16 of the bulge 32 to an exterior surface thereof.

15 A golf club shaft according to claim 1, characterised in that the body is formed with an axial opening which

extends through the body and which is tapered inward toward the axis 14 of the body from the outboard extremity of the butt end 20 to the opposite end of the body.

16 A golf club shaft according to claim 1, characterised in that the intermediate section 26 is formed at a prescribed length having:

a first segment which tapers at a first taper-rate inward toward the axis 14 of the body from the inboard extremity of the butt end 20 to an intermediate juncture located at an axial distance from the inboard extremity of the butt end which is less than the prescribed length; and

a second segment which tapers at a second taper-rate inward toward the axis 14 of the body from the intermediate juncture to a termination of the intermediate section as defined by the prescribed length.

17 A golf club shaft according to any of claims 1 to 16, characterised in that the non-metallic material is a composite material formed by non-metallic fibres and a cured plastic matrix.

18 A golf club shaft according to claim 17, characterised in that the non-metallic fibres are composed of graphite and the cured plastic matrix is a cured epoxy resin.

19 A golf club 10, which comprises:

a shaft 12 having a body composed of a non-metallic material 15 extending longitudinally along an axis 14 of the body;

the body formed with a butt end 20 formed at one end thereof having an inboard extremity of a prescribed diameter and an outboard extremity;

the body formed with a tip end 24 formed at an end thereof axially opposite the butt end 20 and spaced axially

therefrom and having an inboard extremity of a diameter less than the prescribed diameter and an outboard extremity;

the body formed with an intermediate section 26 which extends from the inboard extremity of the butt end 20 toward the tip end 24 wherein the diameter of an end of the intermediate section 26 which joins the butt end 20 is the same as the prescribed diameter and the diameter at an opposite end of the intermediate section 26 is less than the diameter of the inboard extremity of the butt end 20;

the body formed with a bulge 32 along the axis 14 of the body;

portions of the body immediately adjacent the bulge 32 formed by the non-metallic material 15 extending outward from a location in the immediate vicinity of the axis for a first prescribed distance from the axis to an outer surface of the portions of the body;

the bulge 32 formed by the non-metallic material 15 extending outward from a location closer to the axis 14 than the outer surface of the immediately adjacent portions of the body for a second prescribed distance, greater than the first prescribed distance, from the axis to an outer surface of the bulge 32;

a grip 18 assembled on the butt end 20 of the body; and

a club head 22 assembled on the tip end 24 of the body.

20 A golf club according to claim 19, characterised in that the bulge 32 is formed with a central section 34, a first transition section 36 and a second transition section 38 with the first transition section 36 joined between one end of the central section 34 and the portion of the body immediately adjacent the first transition section 36 and the second transition section 38 joined between an opposite end of the central section 36 and the portion of the body immediately adjacent the second transition section 38.

21 A golf club according to claim 20, characterised in that each of the first and second transition sections 36,38 are formed with exterior surfaces which are tapered outward from their respective juncture with the portion of the body to their juncture with the central section 34.

22 A golf club according to claim 20, characterised in that the central section 34 is formed with an exterior surface in a generally cylindrical shape.

23 A golf club according to claim 20, characterised in that the first transition section 36 is closer to the tip end 24 of the body, and of an axial length greater than the axial length of the second transition section 38.

24 A golf club according to claim 19, characterised in that the bulge 32 is formed with an axial opening 16 therethrough having a wall which is circular at any transaxial section thereof and which is straight from an inboard end of the bulge 32 to an outboard end thereof.

25 A golf club according to claim 19, characterised in that the diameter of the opening 16 of the bulge 32 is less than the diameter of any external portion of the body immediately adjacent the bulge 32.

26 A golf club according to any of claims 19 to 25, characterised in that the bulge 32 is formed by a composite material 15 including non-metallic fibres and a cured plastic matrix.

27 A golf club according to claim 24, characterised in that the composite material 15 of the bulge 32 extends radially from the opening of the bulge 32 to an exterior surface thereof.

28 A golf club according to claim 19, characterised in that the intermediate section 26 is formed with a prescribed length having:

a first segment which tapers at a first taper-rate inward toward the axis 14 of the body from the inboard extremity of the butt end 20 to an intermediate juncture located at an axial distance from the inboard extremity of the butt end 20 which is less than the prescribed length; and

a second segment which tapers at a second taper-rate inward toward the axis 14 of the body from the intermediate juncture to a termination of the intermediate section 26 as defined by the prescribed length.

29 A golf club according to claim 19, characterised in that the non-metallic material 15 includes graphite fibres and a cured epoxy resin.

30 A golf club substantially as herein described with reference to the accompanying drawings.

The Patent Office

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Application No: GB 9705266.6 **Examiner:** Alan Blunt
Claims searched: 1 to 30 **Date of search:** 4 June 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): A6D (D21A, D21C)

Int Cl (Ed.6): A63B 53/10

Other:

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB2250443A	(TAYLOR MADE) - Figure 3)	1 to 30
X,P	US5551691	(HARADA) - whole document	1 to 30
X	US5496028	(CHIEN) - Figure 12	1 to 30
&	GB2297265A	(RALPH COMPOSITE)	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.