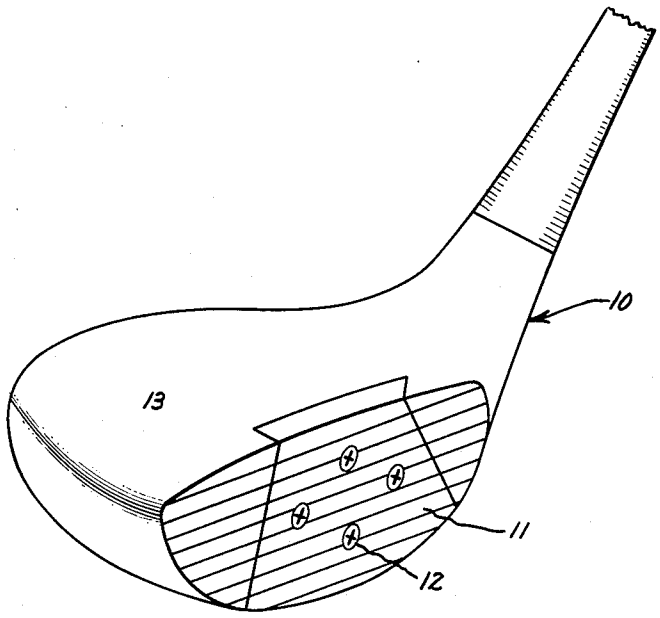
Feb. 8, 1966 D. G. FLOM 3,233,905

GOLF CLUB STRIKING SURFACE OF POLYCARBONATE

Filed April 26, 1961



Inventor:
Donald G. Flom,
by James J. Lichiello
His Attorney.

United States Patent Office

3,233,905

Patented Feb. 8, 1966

1

3,233,905

GOLF CLUB STRIKING SURFACE OF POLYCARBONATE

Donald G. Flom, Scotia, N.Y., assignor to General Electric Company, a corporation of New York

Filed Apr. 26, 1961, Ser. No. 105,665
4 Claims. (Cl. 273—173)

This invention relates to resilient impact surfaces and more particular to a resilient surface for an impact member adapted to strike an object for the transmittal of energy thereto, such member being as one example, a golf club.

Golf club manufacture has become more precise in the requirements and specifications of the materials or the final form which will provide or achieve various objectives. One important objective of primary concern, is the resulting distance a golf ball will travel upon being struck or driven by a golf club. This however depends to a great extent on the characteristics of the club itself. Disregarding for the purposes of this invention, the matching of the club to the driver or operator, or the relative skill of the driver or operator, golf clubs have certain characteristics which may be selected. For example, the clubs themselves may be long or short, the clubheads may be of different and varying weights, and the shaft may have graded degrees of flexibility. Each characteristic may be advertised as providing certain beneficial results, and it is well known that even a small improvement provides something worthy of note. However, the distance a golf ball will travel after being struck depends to a considerable extent on the impact surfaces, i.e. the ball and the club.

A golf clubhead is usually made of a waterproof laminate of persimmon wood; however, the striking surface, or impact face, is usually provided by a small insert of a different material than the clubhead. It is obvious, therefore, that the insert material definitely affects the distance a ball will travel after having been struck. The effect may be described in terms of dynamic losses of energy that take place in the insert material, and the greater these losses, the less distance a given ball will travel after a given amount of energy is directed thereto. In the game of golf, dynamic losses are of great importance because of the normally long distances a ball should carry.

Accordingly, it is an object of this invention to provide an improved surface for impact members, which surface is to be exposed to severe impact fatigue conditions.

It is another object of this invention to provide an improved insert material for golf clubs, with low energy loss.

It is another object of this invention to provide a polycarbonate resin insert for golf clubs.

Briefly described, this invention includes an impact or striking member, for example, a golf club, with its impact surface being of a polycarbonate resin having low dynamic losses, in order to more effectively transmit energy from the golf club to the golf ball.

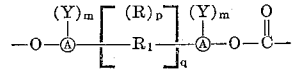
This invention will be more clearly understood when taken in connection with the following description and the drawing in which:

FIG. 1 is an illustration showing a polycarbonate resin insert in a standard golf club.

The losses which take place between an insert material for a golf club and a ball, may be minimized by a material having an improved ability to more effectively transfer energy from the club to the ball. Such an insert material is conventionally manufactured from cotton and synthetic resin to provide a tough water-proof material having good characteristics with respect to the exchange of energy.

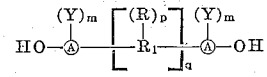
2

It has been discovered, however, that a polycarbonate resin is a much improved material for golf club inserts. The polycarbonate resin material of this invention compries a linear polymer comprising recurring structural units of the formula

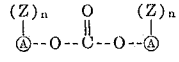
I 

where R is a monovalent hydrocarbon radical; R_1 is selected from the group consisting of an alkylene and an alkylidene residue; A is the residue of an aromatic nucleus; Y is a chemical constituent selected from the group consisting of (a) inorganic atoms (b) inorganic radicals and (c) organic radicals; *m* is a whole number equal to from 0 to a maximum determined by the number of replaceable nuclear hydrogens substituted on the aromatic hydrocarbon residue A; *p* is a whole number equal to from 0 to a maximum determined by the number of replaceable hydrogens on R_1; and *q* is a whole number equal to from 0 to 1 inclusive.

One method of preparing these resins comprises effecting reaction between (1) a dihydroxydiaryl compound of the formula

II 

and (2) a diaryl carbonate of the formula

III 

where R is a monovalent hydrocarbon radical; R_1 is selected from the group consisting of an alkylene and an alkylidene residue; A is the residue of an aromatic nucleus; Y and Z are chemical substituents selected from the group consisting of (a) inorganic atoms (b) inorganic radicals and (c) organic radicals, (a), (b) and (c) being inert to and unaffected by the reactants and by the reaction of the dihydroxydiaryl compound and the diaryl carbonate; *m* and *n* are whole numbers equal to from 0 to a maximum equivalent to the number of replaceable nuclear hydrogens substituted on the aromatic hydrocarbon residue A; *p* is a whole number equal to from 0 to a maximum determined by the number of replaceable hydrogens on the alkylene or alkylidene residue; and *q* is a whole number equal to from 0 to 1 inclusive.

In the above formula for the dihydroxydiaryl compound (hereinafter employed as a designation for the compound defined in Formula II), the inert substituents designated by Y on each aromatic hydrocarbon residue may be the same or different, and R's may also be the same or different; the number of Y's on each respective aromatic hydrocarbon nucleus residue A may also be varied if desired so that a symmetrical or an unsymmetrical compound be formed. The Z's in the diaryl carbonate defined by Formula III may also be the same or different, and the number of substituents represented by Z may be the same on each aromatic nucleus A, or may vary depending upon the degree of substitution desired on each aromatic residue A.

Among the monovalent hydrocarbon radicals which R may represent are, for instance alkyl radicals (e.g., methyl, ethyl, propyl, isopropyl, butyl, decyl, etc.), aryl radicals (e.g., phenyl, naphthyl, biphenyl, tolyl, xylyl, ethylphenyl, etc.), aralkyl radicals (e.g., benzyl, phenylethyl, etc.), cycloaliphatic radicals (e.g., cyclopentyl, cyclohexyl, etc.), as well as monovalent hydrocarbon radicals containing inert substituents thereon, for instance, halogens (e.g., chlorine, bromine, fluorine, etc.). Among the aromatic nuclei which A may represent are, for instance, the aromatic hydrocarbon residues based on benzene, biphenyl, naphthalene, anthracene, etc. The final configura-

tion of this aromatic hydrocarbon residue in the molecule is determined by the nuclearly-substituted hydroxyl groups, together with any nuclearly-substituted hydrogen atoms and the number of inert substituents represented by either Y or Z.

Examples of R_1 as an alkylene or alkylidene residue are, for instance, methylene, ethylene, propylene, propylidene, isopropylidene, butylene, butylidene, isobutylidene amylene, isoamylene, amylidene, isoamylidene, etc. When p is zero, the valence requirements of the carbon skeleton of the alkylene or alkylidene residue are completely satisfied with hydrogens. When p is greater than zero, hydrogens fulfill the valence requirements of the carbon skeleton not satisfied by the R's.

Among the inert substituents which Y and Z may represent are, for instance, halogens (e.g., chlorine, bromine, fluorine, etc.); organoxy radicals of the formula OW, where W is a monovalent hydrocarbon radical similar to those recited for R; and monovalent hydrocarbon radicals of the type represented by R. Other inert substituents included within the scope of Y and Z, such as the nitro group, may be substituted on the aromatic nuclear residue A without departing from the scope of the invention.

In the above formulae, m and n may be zero whereby the aromatic nuclear residue A will be unsubstituted except for the hydroxyl group in regard to Formula II, or else there may be a plurality of substitutions of inert substituents on the aromatic nuclear residues depending upon the number of nuclearly bonded hydrogens remaining on A, taking into consideration the presence of the hydroxyl group in Formula II. Where q is zero the aromatic nuclei will be directly joined without the presence of an alkylene or an alkylidene bridge.

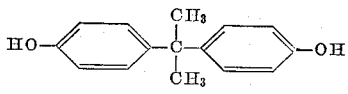
The position of the hydroxyl groups, Y and Z on the aromatic nuclear residue A, may be varied in the ortho, meta or para positions, and the groupings may be in a vicinal, asymmetrical, or symmetrical relationship, where two or more of the nuclearly-bonded hydrogens of the aromatic hydrocarbon residue are substituted with, for instance, Y, the hydroxyl group in Formula II.

One method of preparing a polycarbonate resin linear polymer is given in the following example:

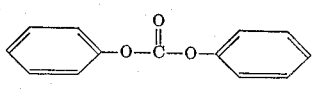
Example 1

This example is illustrative of the reaction of equimolar ratios of technical grades of bisphenol-A and diphenyl carbonate.

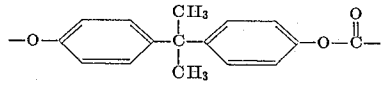
Equimolar ratios of bisphenol-A,

IV 

(114 parts) and diphenyl carbonate,

V 

(107 parts), were charged to an oil bath heated reactor equipped with a stirrer, an inert gas inlet, a condenser-receiver system connected to a vacuum means for creating subatmospheric pressure. Nitrogen was slowly allowed to enter the reactor system to which vacuum was gradually applied. Initial distillation of phenol began when the bath temperature reached 185–190° C. (after ½ hour of heating) and continued rapidly for 1–1.5 hours at this temperature and a pressure of 10 mm. during which time most of the phenol was evolved. The temperature of the heating bath was then solwly raised to 290° C. under the nitrogen-reduced pressure system (about 10 mm.) and held at this point for about 5 additional hours during which time the viscosity of the reaction mixture increased. Long fibers could be drawn from the hot melt. The carbonate resin product (melting point 280–300° C.) comprised recurring units of the formula



The resin had an intrinsic viscosity of 0.355 as determined in p-dioxane at a temperature of 30.3±0.1° C. using an Ostwald viscometer, hereafter referred to as "p-dioxane 30.3±0.1° C."

Further examples of polycarbonate resins or poly (di monohydroxy arylene alkene carbonate) may be found in copending application Serial No. 598,768, Fox et al., filed July 19, 1956, assigned to the same assignee as the present invention, and incorporated by reference herewith. Other polycarbonate resins and methods of preparation are found in U.S. Patents 2,964,794 and 2,950,266.

Rebound and rolling friction measurements of a polycarbonate resin of this invention indicate that the dynamic losses therein over a wide range of temperatures are much lower than those of other thermoplastic materials.

Rebound tests were conducted by measuring rebound distances of balls from a given surface. In the test, different material balls were employed and dynamic losses (tan. σ) were .05, .06, .07 for polycarbonate resin, polymethyl methacrylate (Plexiglas) and linear superpolyamide (nylon), respectively.

Rolling friction tests were conducted with ¼ inch steel balls rolling on a given material surface at room temperature and under about 500-gram load. The results were λ of .0005 polycarbonate resin, .0012 Plexiglas and .0006 nylon.

This invention has been practiced with the golf club illustrated in FIG. 1. In FIG. 1, golf club 10 is a standard number 2 wood having a conventional resin insert 11 providing the insert or striking face. Screws 12 are employed to attach insert 11 to the clubhead 13. This club was employed to drive about 15 golf balls with a head velocity of about 4500 cm. per sec. and an average driving distance of 186±12 yards was obtained. As comparison, a standard number 3 wood containing a polycarbonate resin insert was employed to drive about 15 golf balls, under the conditions previously described, and an average distance of 191±14 yards was obtained. An epoxy adhesive was employed between the insert and the clubhead in addition to screws 12. Since a number 2 wood driver will be expected normally to give at least 10 yards greater distance than a number 3 wood, the improvement attributable to the polycarbonate resin insert was about 15 yards. It is apparent that there are less dynamic losses in the polycarbonate resin and greater resilience. When employed as an insert the polycarbonate resin should be about 3/16 inch thick and in the general range of about ⅛ inch to ¼ inch. It is important that the insert be securely attached to the golf club in order to minimize the energy losses at the interface as well as within the insert itself.

The objects of this invention are achieved when the striking surface of an impact member is a polycarbonate resin. Various impact members of industrial or tool application as well as devices associated with sports may take advantage of the teachings of this invention to incorporate a polycarbonate resin striking surface. In a golf club application the polycarbonate resin is preferably in the form of an insert, as illustrated, and where the ball utilizes the transferred energy for its resulting motion. In golfing, the resiliency of the insert and resiliency of the ball are utilized for free flight conditions. The insert of this invention thus provides more transfer of energy for the same amount of input force.

While the description thus far has more particularly been directed to a polycarbonate resin striking or impact surface, it is to be understood that the surface may in-

clude a considerable portion or all of a given impact member. For example, in the golf club application the entire clubhead may be suitably formed or molded from the polycarbonate resin. The same interpretation is equally applied to various batting sport devices.

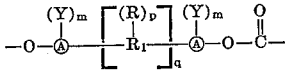
Where the particular device in question utilizes a shaft member subjected to bending moments the shaft itself in whole or part may also be made of polycarbonate resin in accordance with the teachings of this invention.

While a specific method and apparatus in accordance with this invention has been shown and described, the invention is not limited to the particular description nor to the particular configurations illustrated, and it is intended by the appended claims to cover all modifications within the spirit and scope of this invention.

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

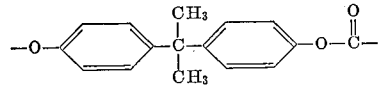
1. In a golf club having a shaft portion and a head portion having an impact face thereon, the improvement comprising said impact face being provided by a polycarbonate resin insert.

2. The invention as recited in claim 1 wherein the polycarbonate resin of which the insert is made comprises, recurring units of the formula

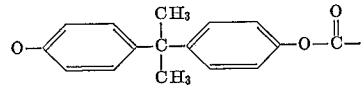


wherein R is a monovalent hydrocarbon radical; R_1 is selected from the group consisting of an alkylene and an alkylidene residue; A is a residue of an aromatic nucleus; Y is selected from the group consisting of inorganic atoms, inorganic radicals and organic radicals; *m* is a whole number equal to from 0 to a maximum equivalent to the number of replaceable nuclear hydrogens substituted on the aromatic hydrocarbon residue A; *p* is a whole number equal to from 0 to a maximum determined by the number of replaceable hydrogens on R_1; and *q* is a whole number equal to from 0 to 1 inclusive.

3. The invention as recited in claim 1 wherein the polycarbonate resin of which the insert is made comprises, recurring units of the formula



4. In a golf club having a shaft portion and a head portion having an impact face thereon, the improvement comprising said impact face being of polycarbonate resin, said polycarbonate resin having recurring units of the formula



References Cited by the Examiner

UNITED STATES PATENTS

700,946	5/1902	Kempshall	273—78
1,463,533	7/1923	Kurz	273—173
1,654,257	12/1927	Hillerich	273—173
1,840,451	1/1932	Jansky	273—173
2,486,952	11/1949	Kearsley et al.	273—167
2,880,002	3/1959	Wetty	273—167 XR
2,934,345	4/1960	Scott	273—80
2,991,080	7/1961	Redmond	273—80
2,991,273	7/1961	Hechelhammer et al.	
3,002,757	10/1961	Marciniak	273—167

FOREIGN PATENTS

773,162	4/1957	Great Britain.

OTHER REFERENCES

Chemical Week for April 6, 1957; pages 96, 98, 100 cited.

Modern Plastics for April 1958; pages 131–139.

Machine Design for Nov. 26, 1959; pages 152, 153, 154.

RICHARD C. PINKHAM, *Primary Examiner.*