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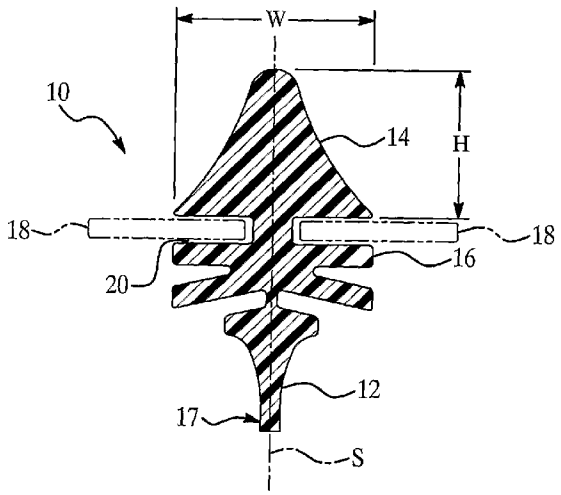
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(54) Title: WIPER BLADE ASSEMBLY AND METHOD OF FORMING THE SAME



(57) Abstract: A wiper blade assembly (10) includes a wiper blade member (12) and an airfoil member (14) operatively. connected to the wiper blade member (12) . The airfoil member (14) extends longitudinally along at least a portion of the length of the wiper blade member (12) . The airfoil member (14) also has a cross-sectional profile that is symmetrical about a plane of symmetry (5) extending through a center of the airfoil member (14) and longitudinally through the airfoil member (14) .

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WIPER BLADE ASSEMBLY AND METHOD OF FORMING THE SAME

BACKGROUND

The present disclosure relates generally to wiper blade assemblies, and more particularly to wiper blade assemblies having airfoils.

At high vehicle speeds, wiper blades may be subjected to aerodynamic lift forces that tend to lift the blades off the windshield, which may reduce the effectiveness of the blade. In efforts to increase blade efficiency, wiper arm designs generally employ springs to create downward pressure on the wiper blades. Some other systems include wiper blade designs which provide additional aerodynamic downward forces from the wiper blade interacting with the air stream. Although these wiper blade designs may be desirable in some instances, there may be some wiper systems in which these additional aerodynamic downward forces are not desirable.

Some efforts to increase blade effectiveness may include the addition of airfoils on the wiper blades. Generally, airfoils aid in controlling airflow over the wiper blade as an air stream flows over the body of the vehicle. Airfoils may, in some instances, generate a downward aerodynamic force, which pushes the wiper blade into contact with the windshield.

Many airfoils have curved sections that are attached to the top of the wiper blade or to the wiper arm, with a concave asymmetrical surface facing the oncoming air stream. While these airfoils have been effective in increasing the downward aerodynamic force on the wiper blade, there is the possibility that they may create increasing drag as wind velocity increases. In some instances, this type of airfoil may be associated with an increased amount of "pullback." "Pullback" is generally defined as the rewetting of the wiped surface on the trailing side of the wiper blade as the wiper blade reverses direction. The rewetted area may cause undesirable temporary optical distortion through the windshield.

As such, it would be desirable to provide a wiper blade assembly that substantially eliminates blade lift during normal vehicle operation, while reducing the amount of pullback experienced with some current designs.

SUMMARY

The present disclosure provides a wiper blade assembly. The wiper blade assembly includes a wiper blade member having a length and an airfoil member operatively connected to the wiper blade member. The airfoil member extends longitudinally along at least a portion of the wiper blade member length. The airfoil member also has a cross-sectional profile that is symmetrical about a plane of symmetry extending through a center of the airfoil member and longitudinally through the airfoil member.

BRIEF DESCRIPTION OF THE DRAWINGS

Features and advantages of the present disclosure will become apparent by reference to the following detailed description and drawings, in which like reference numerals correspond to similar, though not necessarily identical components. For the sake of brevity, reference numerals or features having a previously described function may not necessarily be described in connection with other drawings in which they appear.

Fig. 1 is a perspective view of an embodiment of a wiper blade assembly;

Fig. 2 is an enlarged cross-sectional view taken along line 2-2 of Fig. 1, depicting the wiper blade assembly engaged with two wiper blade splines;

Fig. 3 is a semi-schematic cross-sectional view of an alternate embodiment of the wiper blade assembly engaged with a wiper blade spline;

Fig. 4 is a semi-schematic cross-sectional view of an embodiment of the wiper blade assembly having a bell curve shaped cross-sectional profile;

Fig. 5 is a semi-schematic cross-sectional view of an alternate embodiment of a wiper blade assembly having a cardioid shaped cross-sectional profile;

Fig. 6 is a semi-schematic view of a windshield, a wipe pattern, and two pullback paths;

Figs. 7A through 7D are semi-schematic cross-sectional views depicting alternate embodiments of a wiper blade assembly; and

Fig. 8 is a semi-schematic perspective view of an embodiment of the wiper blade assembly engaging two wiper blade splines and a clip.

DETAILED DESCRIPTION OF THE EMBODIMENTS

Embodiment(s) of the wiper blade assembly disclosed herein include airfoils having symmetrical profile designs that may advantageously assist in reducing pullback and aerodynamic blade lift. Without being bound to any theory, it is believed that embodiment(s) of the wiper blade assembly may reduce aerodynamic lift and pullback at various vehicle speeds, including high vehicle speeds (e.g. 70 mph/113 kph). It is to be understood that the embodiment(s) of the wiper blade assembly may be used in any applications involving directional airflow. In a non-limitative example, the wiper blade assembly is used in conjunction with a vehicle windshield wiper system. Other non-limitative examples of systems in which the wiper blade assembly may be used include head lamp wiper systems, vehicle rear window wiper systems, train wiper systems, aircraft wiper systems, water vehicle wiper systems, and/or the like.

Referring now to Fig. 1, an embodiment of a wiper blade assembly 10 is depicted. The wiper blade assembly 10 generally includes a wiper blade member 12 and an airfoil member 14 operatively connected to the wiper blade member 12. Suitable materials for both the wiper blade member 12 and the airfoil member 14 include, but are not limited to polymeric materials (non-limitative examples of which include plastic materials, elastomeric materials (natural and/or synthetic), silicone materials, and/or the like, and/or combinations thereof). It is to be understood that the airfoil member 14 may be a composite of two or more materials. It is to be further understood that the wiper blade member 12 may be a composite having, for example, a polymeric material supported by or commingled with carbon fiber(s). In a non-limitative example of the wiper blade assembly 10, the wiper blade member 12 is made of natural rubber and the airfoil member 14 is made of ethylene propylene diene

monomer (EPDM). In another non-limitative example of the wiper blade assembly 10, the wiper blade member 12 is made of polypropylene and the airfoil member 14 is a thermoplastic elastomer (TPE) (a non-limitative example of which includes SANTOPRENE, which is commercially available from Advanced Elastomer Systems, LP, an ExxonMobil Chemical Affiliate, located in Akron, OH).

In an embodiment, the wiper blade member 12 has a length L, and the airfoil member 14 extends longitudinally along at least a portion of the wiper blade member length L. As shown in Fig. 1, the airfoil member 14 may extend the entire length L of the wiper blade member 12.

The airfoil member 14 has a cross-sectional profile (shown in detail in Figs. 2-4 and Figs. 6A-6D) that is symmetrical about a plane of symmetry S. It is to be understood that the plane of symmetry S extends through a center of the airfoil member 14 and longitudinally through the airfoil member 14, as shown in Fig. 1. It is to be understood that the symmetrical cross-sectional profile is designed to substantially prevent lift of the wiper blade assembly 10, while substantially reducing undesirable pullback when the assembly 10 is subjected to aerodynamic forces during vehicle operation. Generally, the wiper blade assembly 10 during use, at air speeds of about 50 m/s, may experience lift forces ranging from about 3 N/m to about 14 N/m, and drag forces ranging from about 11 N/m to about 22 N/m. In an embodiment, the wiper blade assembly 10 includes a supporting member 16 positioned between the wiper blade member 12 and the airfoil member 14. It is to be understood that the supporting member 16 may add a desired degree of rigidity to the assembly 10. In one embodiment, supporting member 16 is spaced from the airfoil member 14, thereby defining one or more grooves 20 therebetween. Each groove 20 is adapted to engage a wiper blade spline 18 (an embodiment of which is shown in Fig. 2). In another embodiment, supporting member 16 has a channel 21 defined therein. The channel 21 is adapted to engage a wiper blade spline 18 (an embodiment of which is shown in Fig. 3).

The supporting member 16 may be formed integrally with the wiper blade member 12 and the airfoil member 14 (as shown in Figs. 1 and 2), or it may be

a separate piece that bridges the two members 12, 14 (as shown in Fig. 3). Generally, the supporting member 16 may be formed of one or more polymeric materials (non-limitative examples of which include plastic materials, thermoplastic materials, elastomer materials (natural and/or synthetic), thermoplastic elastomer materials (TPE), silicone materials, and/or combinations thereof).

Fig. 1 also depicts a rotation axis R substantially perpendicular to the length L. It is to be understood that the symmetrical wiper blade assembly 10 may be rotated about 180° about the rotation axis R after the assembly is used (e.g. in conjunction with a vehicle wiper system) for predetermined time intervals. In a non-limitative example, after the assembly 10 is used for a time interval of about three-months (where one side 13 of the wiper blade member 12 in a non-operating position may be in contact with the windshield for prolonged periods of time), the user may rotate the assembly 10 about 180° about the rotation axis R such that the other side 15 of the wiper blade member 12 contacts the windshield in the non-operating position. By rotating the wiper assembly 10 in this manner, the present disclosure advantageously may avoid the occurrence of a "permanent set" condition. As defined herein, "permanent set" refers to a material (e.g. wiper blade member 12) that is deflected so far that its elastic properties have been exceeded and generally will not return to its original condition upon release of load. Without being bound to any theory, it is believed that this rotation of the wiper blade assembly 10 about 180° about the rotation axis R after predetermined time intervals may advantageously extend the useful life of the wiper blade assembly 10.

Referring now to Fig. 2, a cross-sectional view of the embodiment of the wiper blade assembly 10 shown in Fig. 1 is depicted. In this embodiment, the assembly 10 includes an integrally formed wiper blade member 12 having a wiping section 17, supporting member 16, and airfoil member 14.

As shown, the assembly 10 is capable of slidingly engaging a wiper blade spline 18 (shown in phantom) in each of the two grooves 20 defined between the airfoil member 14 and the supporting member 16. It is to be understood that the wiper blade spline(s) 18 may also include end caps (not

shown) that engage the opposed ends of the wiper blade assembly 10, aiding in preventing assembly 10 from undesirable disengagement from wiper blade spline(s) 18. In an embodiment, the wiper blade spline 18 may attach to a clip 26 (schematically shown in Fig. 8), which aids in attaching the wiper blade assembly 10 to the vehicle wiping system (not shown).

The embodiment of the airfoil member 14 shown in Fig. 2 has a symmetrical cross-sectional profile in the shape of a bell curve (described further herein in reference to Fig. 4). It is to be understood that the symmetrical cross-sectional profile of the airfoil member 14 may be any suitable shape, including, but not limited to variation(s) of the bell curve shape, cardioid shapes, triangular shapes, and/or the like.

In the embodiments disclosed herein, the airfoil member 14 has a height H and a width W. In an embodiment, the height H of the airfoil member 14 may range from about 4 mm to about 30 mm, and the width W may range from about 6 mm to about 40 mm. It is to be understood that the airfoil member 14 height H and width W may vary, depending, at least in part, on the application in which the wiper blade assembly 10 is being used. Further, the width W of the airfoil member 14 may be determined, at least in part, by the size of the wiper blade spline(s) 18 being used. For example, if a relatively wide wiper blade spline 18 is used, a relatively wide airfoil member 14 may be desirable.

Referring now to Fig. 3, an alternate embodiment of the wiper blade assembly 10 is depicted. The assembly 10 includes an airfoil member 14, a supporting member 16, and a wiper blade member 12 supported by the supporting member 16.

As shown, the assembly 10 is capable of slidingly engaging a wiper blade spline 18 (shown in phantom) in the channel 21 defined in the supporting member 16. It is to be understood that the channel 21 may extend through the supporting member 16 substantially the length L of the wiper blade assembly 10.

The embodiment of the supporting member 16 shown in Fig. 3 is also designed to engage (e.g. slidingly) an end portion 19 of the wiper blade member 12 which is distal to the wiping section 17. As such, the wiper blade

member 12 in this embodiment is generally not formed integrally with the airfoil member 14. It is to be understood that end caps (not shown) may aid in preventing undesirable disengagement of the wiper blade spline 18 and/or the wiper blade member 12.

Figs. 4 and 5 depict, in detail, alternate embodiments of cross-sectional profiles of the airfoil member 14. Specifically, Fig. 4 depicts an airfoil member 14 having one variation of a bell curve shaped symmetrical cross-sectional profile, and Fig. 5 depicts an airfoil member 14 having a cardioid shaped symmetrical cross-sectional profile.

Referring now to Fig. 4, the airfoil member 14 having the bell curve shaped cross-sectional profile generally includes two sides and a top. In an embodiment, side circular arcs A_1, A_2, respectively, define each of the sides of the bell curve shaped cross-sectional profile. Each of the side circular arcs A_1, A_2 has a respective center C_1, C_2, each of which is external to the cross-sectional profile. The radii R_1, R_2 of the respective side circular arcs A_1, A_2 may range from about 8 mm to about 16 mm.

In this embodiment, a top circular arc A_3 defines the top of the bell curve shaped cross-sectional profile of the airfoil member 14 depicted in Fig. 4. It is to be understood that the top circular arc A_3 has a center C_3 substantially on the plane of symmetry S and internal to the cross-sectional profile. The radius R_3 of the top circular arc A_3 may range from about 0.5 mm to about 6 mm.

Referring now to Fig. 5, the airfoil member 14 having a cardioid shaped cross-sectional profile generally includes two sides and a top. In an embodiment, a side circular arc A_4, A_5 respectively defines each of the sides of the cardioid shaped cross-sectional profile. Each of the side circular arcs A_4, A_5 has a respective center C_4, C_5, each of which is internal to the cross-sectional profile. The radii R_4, R_5 of the respective side circular arcs A_4, A_5 range from about 8 mm to about 16 mm.

In this embodiment, a top circular arc A_6 defines the top of the cardioid shaped cross-sectional profile of the airfoil member 14 depicted in Fig. 5. It is to be understood that the top circular arc A_6 has a center C_6 substantially on the

plane of symmetry S and internal to the cross-sectional profile. The radius R_6 of the top circular arc A_6 may range from about 0.5 mm to about 6 mm.

Referring now to Fig. 6, a windshield 22 is depicted from the perspective of a passenger looking outside of the vehicle through the windshield 22. As such, area 24 represents the driver's side of the vehicle.

The windshield wipe pattern WP is a non-limitative example of the path that the wiper blade assembly 10 travels across the windshield 22. P_1 and P_2 illustrate two different pullback patterns, which result from rewetting of the wiped surface on the trailing side of a wiper blade as the blade reverses direction during travel. P_1 is an example of the pullback resulting from use of a non-symmetrical airfoil wiper blade assembly. The pullback distance P_1 (measured from the point at which the blade reverses direction) generally ranges from about 3 cm to about 6 cm. P_2 illustrates the pullback resulting from use of an embodiment of the wiper blade assembly 10 disclosed herein (having a symmetrical airfoil member 14). The pullback distance P_2 (measured from the point at which the blade reverses direction) is generally less than about 3 cm. In a further embodiment, the pullback distance P_2 may range from about 0.5 cm to about 2.5 cm.

Referring now to Figs. 7A through 7D together, alternate embodiments of the wiper blade assembly 10 are depicted. Fig. 7A depicts an airfoil member 14 having a substantially triangular shaped cross-sectional profile with substantially straight sides. Each of the sides is substantially equidistant from the plane S of symmetry. In a non-limitative example, the assembly 10 depicted in Fig. 7A may experience a lift force during use at about 50 m/s (112 mph, 180 kph) of about 5.1 N/m and a drag force of about 19.7 N/m.

Fig. 7B depicts the airfoil member 14 having the cardioid shaped cross-sectional profile. In a non-limitative example, the assembly 10 depicted in Fig. 7B may experience a lift force during use at about 50 m/s (112 mph, 180 kph) of about 8.3 N/m and a drag force of about 17.5 N/m.

Figs. 7C and 7D each depict the airfoil member 14 having various forms of the bell curve shaped cross-sectional profile. In a non-limitative example, the assembly 10 depicted in Fig. 7C may experience a lift force during use at about

50 m/s (112 mph, 180 kph) of about 4.2 N/m and a drag force of about 20.3 N/m. In another non-limitative example, the assembly 10 depicted in Fig. 7D may experience a lift force during use at about 50 m/s (112 mph, 180 kph) of about 4.6 N/m and a drag force of about 20.7 N/m.

It is to be understood that the lift force(s) and drag force(s) experienced by the assembly 10 may vary, depending, at least in part, on the vehicle, the vehicle speed, windshield rake or window rake, and/or the like, and/or combinations thereof.

Referring now to Fig. 8, a system 100 includes an embodiment of the symmetrical wiper blade assembly 10 having wiper blade splines 18 engaged therewith, and a clip 26 (shown schematically) connected thereto. The clip 26 may be attached to the wiper blade assembly 10 via the wiper blade splines 18. The clip 26 may also attach the assembly 10 to a wiper arm (not shown) of a vehicle wiper system.

In an embodiment, the clip 26 and thus the system 100 are symmetrical. It is to be understood that the symmetrical system 100 (including the clip 26) may be rotated about 180° about the rotation axis R. A symmetrical system 100 may advantageously extend the useful life of the wiper blade assembly 10 (as previously described). Further, it is believed that the symmetrical system 100 may substantially eliminate potential assembly problems associated with correctly orienting the system 100 on the vehicle wiper system in which it is included. Still further, a symmetrical system 100 may advantageously be used on either a left-drive vehicle or a right-drive vehicle.

An embodiment of a method of forming an embodiment of a wiper blade assembly 10 as disclosed herein includes operatively connecting the airfoil member 14 to the wiper blade member 12. In an embodiment, the airfoil member 14, the supporting member 16, and/or the wiper blade member 12 may be integrally formed (see Fig. 2), such as, for example, by a dual extrusion process (where one or more materials are used). In a further non-limitative example embodiment, where the airfoil member 14 and the supporting member 16 are formed of the same material, an extrusion process may be used. Further, the wiper blade member 12 may be formed separately and engaged

with the integrally formed (such as, for example, via dual extrusion) supporting member 16 and airfoil 14 (see Fig. 3).

It is to be understood that the wiper blade assembly 10 may be formed using any suitable extrusion process(es) (a non-limitative example of which is a dual extrusion process), co-molding process(es), bonding process(es) (a non-limitative example of which includes adhesive bonding), mechanical attachment process(es), and/or combinations thereof.

Embodiment(s) of the wiper blade assembly 10 and system 100 include, but are not limited to the following advantages. The assembly 10 may advantageously provide minimal pullback with relatively low aerodynamic blade lift at various vehicle speeds. Embodiments of the assembly 10 and system 100 may be rotatable, thereby extending the useful life of the wiper blade member 12. Further, a rotatable system 100 may aid in substantially eliminating potential assembly problems associated with correctly orienting the system 100 on the vehicle wiper system. Still further, the system 100 or assembly 10 may be used with a right-drive vehicle or a left-drive vehicle.

While several embodiments have been described in detail, it will be apparent to those skilled in the art that the disclosed embodiments may be modified. Therefore, the foregoing description is to be considered exemplary rather than limiting.

What is claimed is:

1. A wiper blade assembly, comprising:

a wiper blade member having a length; and

an airfoil member operatively connected to the wiper blade member, the airfoil member extending longitudinally along at least a portion of the wiper blade member length, the airfoil member having a cross-sectional profile that is symmetrical about a plane of symmetry extending through a center of the airfoil member and longitudinally through the airfoil member.

2. The wiper blade assembly as defined in claim 1 wherein the cross-sectional profile substantially prevents wiper blade assembly lift while reducing pullback when the assembly is subjected to aerodynamic forces during vehicle operation.

3. The wiper blade assembly as defined in claim 2 wherein the wiper blade assembly experiences during use, at air speeds of about 50 m/s, a lift force ranging from about 3 N/m to about 14 N/m and a drag force ranging from about 11 N/m to about 22 N/m.

4. The wiper blade assembly as defined in claim 2 wherein the pullback ranges from about 1 cm to about 3 cm.

5. The wiper blade assembly as defined in claim 1 wherein the cross-sectional profile is substantially a bell curve shape having sides and a top, the sides substantially defined by a side circular arc having a center external to the cross-sectional profile and the top substantially defined by a top circular arc having a center substantially on the plane of symmetry and internal to the cross-sectional profile.

6. The wiper blade assembly as defined in claim 1 wherein the cross-sectional profile is substantially a cardioid shape having sides and a top, the sides substantially defined by a side circular arc having a center internal to the

cross-sectional profile and the top substantially defined by a top circular arc having a center substantially on the plane of symmetry and internal to the cross-sectional profile.

7. The wiper blade assembly as defined in claim 1 wherein the cross-sectional profile is substantially a triangular shape having substantially straight sides, each of the sides substantially equidistant from the plane of symmetry.

8. The wiper blade assembly as defined in claim 1, further comprising a supporting member positioned between the airfoil member and the wiper blade member, the supporting member being spaced from the airfoil member, thereby defining at least one groove therebetween, the at least one groove adapted to slidingly engage a wiper blade spline.

9. The wiper blade assembly as defined in claim 8 wherein the supporting member is integral with each of the wiper blade member and the airfoil member.

10. The wiper blade assembly as defined in claim 1, further comprising a supporting member positioned between the airfoil member and the wiper blade member, the supporting member having a channel extending substantially longitudinally therethrough, the channel adapted to engage a wiper blade spline.

11. The wiper blade assembly as defined in claim 10 wherein the airfoil member is integral with the supporting member, and the supporting member is adapted to engage the wiper blade member.

12. The wiper blade assembly as defined in claim 1 wherein the assembly is adapted to wipe a vehicle windshield.

13. The wiper blade assembly as defined in claim 1 wherein the wiper blade assembly is rotatable about 180° about a rotation axis that is substantially perpendicular to the wiper blade member length.

14. A method for forming a wiper blade assembly, the method comprising operatively connecting an airfoil member to a wiper blade member having a length, the airfoil member extending longitudinally along at least a portion of the wiper blade member length, the airfoil member having a cross-sectional profile that is symmetrical about a plane of symmetry extending through a center of the airfoil member and longitudinally through the airfoil member.

15. The method as defined in claim 14 wherein the symmetrical cross-sectional profile substantially prevents wiper blade assembly lift while reducing pullback when the assembly is subjected to aerodynamic forces during vehicle operation.

16. The method as defined in claim 15 wherein the wiper blade assembly experiences during use, at air speeds of about 50 m/s, a lift force ranging from about 3 N/m to about 14 N/m and a drag force ranging from about 11 N/m to about 22 N/m.

17. The method as defined in claim 15 wherein the pullback ranges from about 1 cm to about 3 cm.

18. The method as defined in claim 14 wherein the cross-sectional profile is substantially a bell curve shape having sides and a top, the sides substantially defined by a side circular arc having a center external to the cross-sectional profile and the top substantially defined by a top circular arc having a center substantially on the plane of symmetry and internal to the cross-sectional profile.

19. The method as defined in claim 14 wherein the cross-sectional profile is substantially a cardioid shape having sides and a top, the sides substantially defined by a side circular arc having a center internal to the cross-sectional profile and the top substantially defined by a top circular arc having a center substantially on the plane of symmetry and internal to the cross-sectional profile.

20. The method as defined in claim 14 wherein the cross-sectional profile is substantially a triangular shape having substantially straight sides, each of the sides substantially equidistant from the plane of symmetry.

21. The method as defined in claim 14, further comprising establishing a supporting member between the wiper blade member and the airfoil member and spaced from the airfoil member so as to define at least one groove therebetween, the at least one groove adapted to slidingly engage a wiper blade spline.

22. The method as defined in claim 21 wherein the supporting member is formed integrally with each of the wiper blade member and the airfoil member.

23. The method as defined in claim 14, further comprising establishing a supporting member between the airfoil member and the wiper blade member, the supporting member having a channel extending substantially longitudinally therethrough, the channel adapted to engage a wiper blade spline.

24. The method as defined in claim 14 wherein the wiper blade member is integral with the airfoil member.

25. The method as defined in claim 14 wherein the wiper blade assembly is adapted to wipe a vehicle windshield.

26. The method as defined in claim 14 wherein the wiper blade assembly is rotatable about 180° about a rotation axis that is substantially perpendicular to the wiper blade member length.

27. The method as defined in claim 14 wherein operatively connecting is accomplished by at least one of extrusion processes, co-molding processes, bonding processes, mechanical attachment processes, and combinations thereof.

28. A method for extending a useful life of a symmetrical wiper blade assembly, the method comprising forming a symmetrical wiper blade assembly adapted to be used in a vehicle windshield wiper system for a predetermined time interval after which the wiper blade assembly is adapted to be rotated about 180° about a rotation axis that is substantially perpendicular to a length of the wiper blade assembly;

wherein the wiper blade assembly includes:

a wiper blade member which substantially defines the length of the wiper blade assembly; and

an airfoil member operatively connected to the wiper blade member, the airfoil member extending longitudinally along at least a portion of the wiper blade member length, the airfoil member having a cross-sectional profile that is symmetrical about a plane of symmetry extending through a center of the airfoil member and longitudinally through the airfoil member.

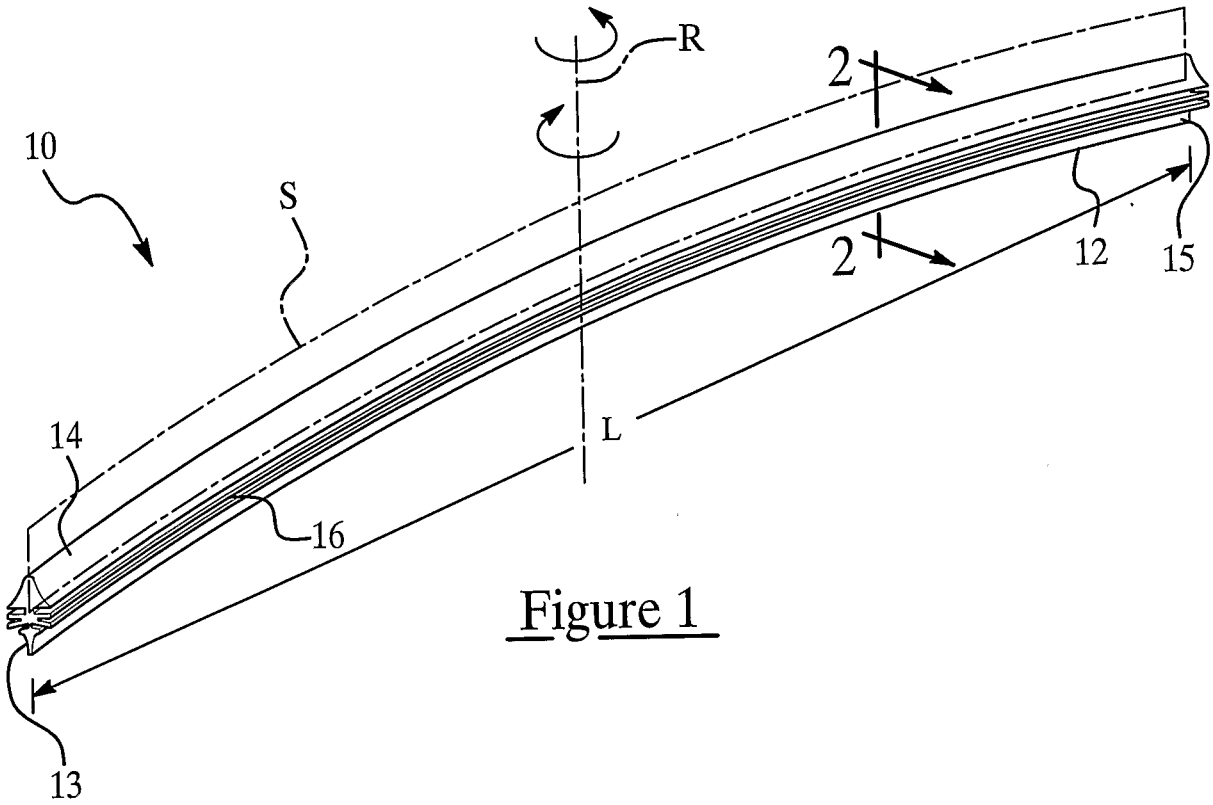


Figure 1

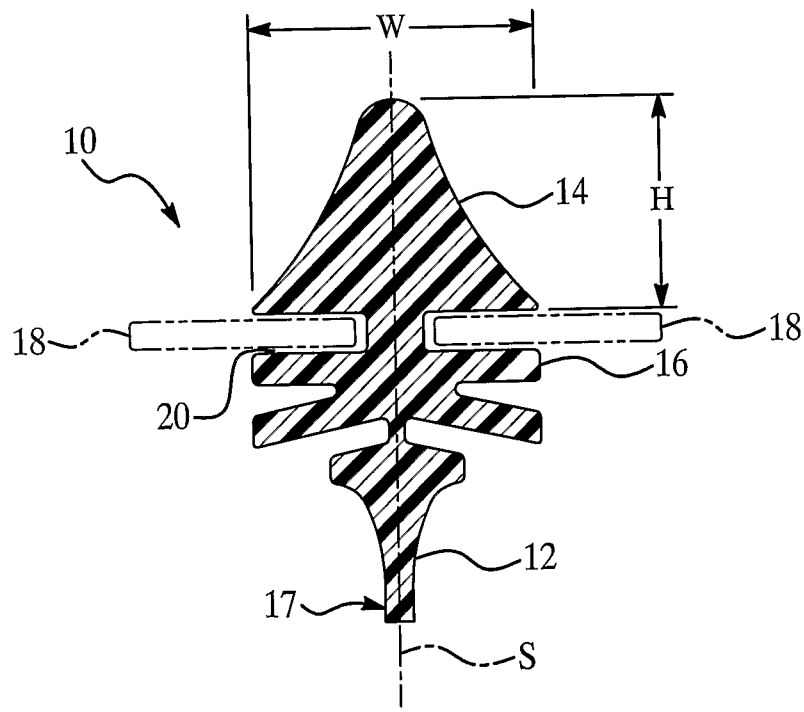


Figure 2

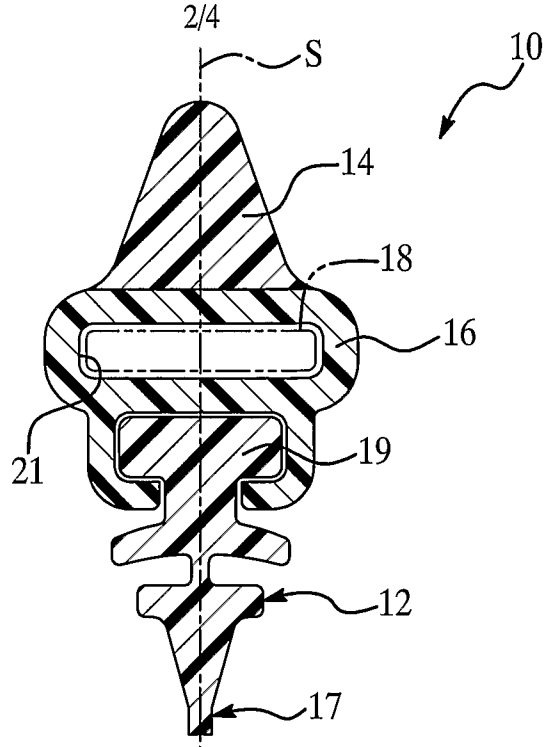


Figure 3

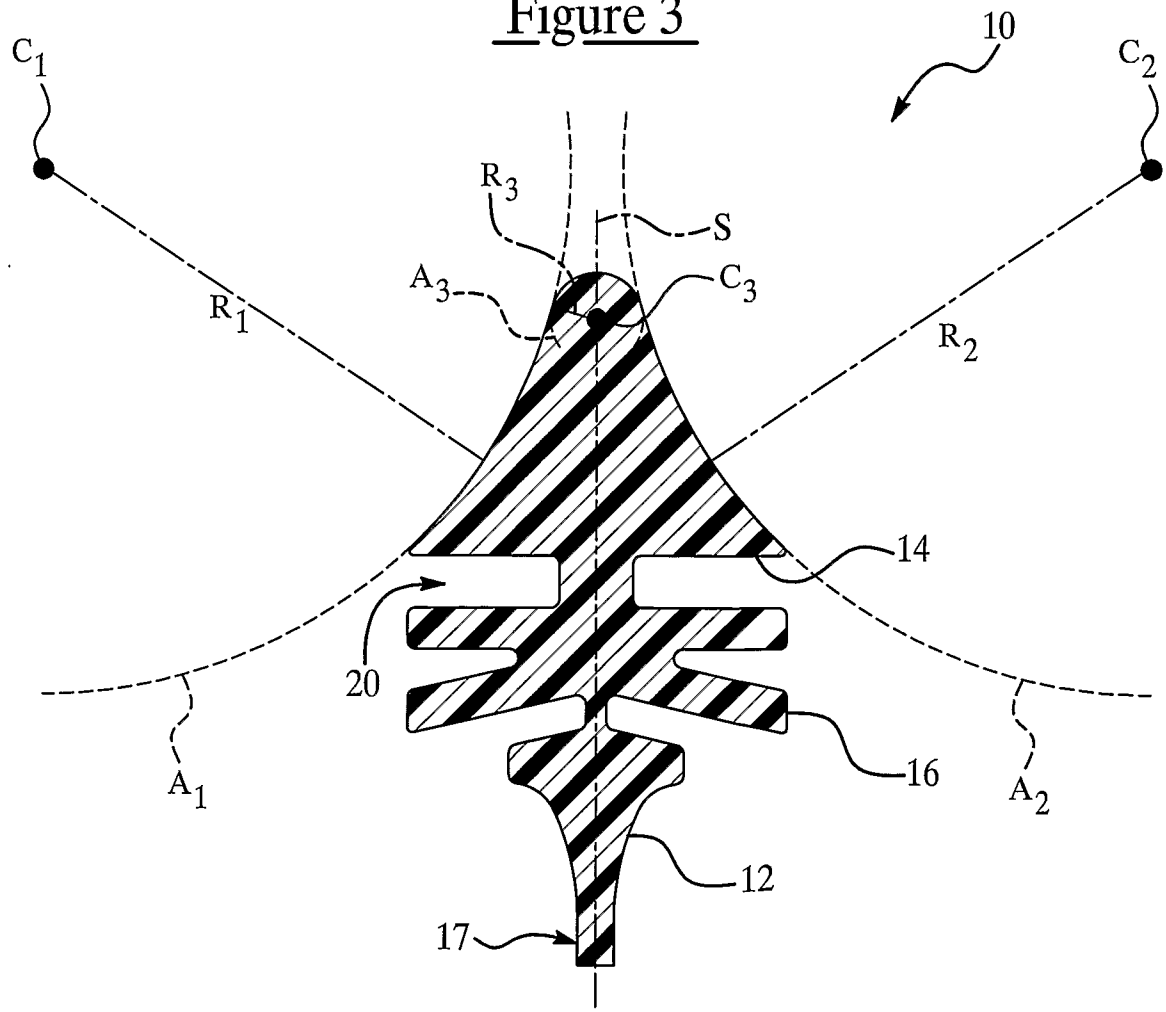


Figure 4

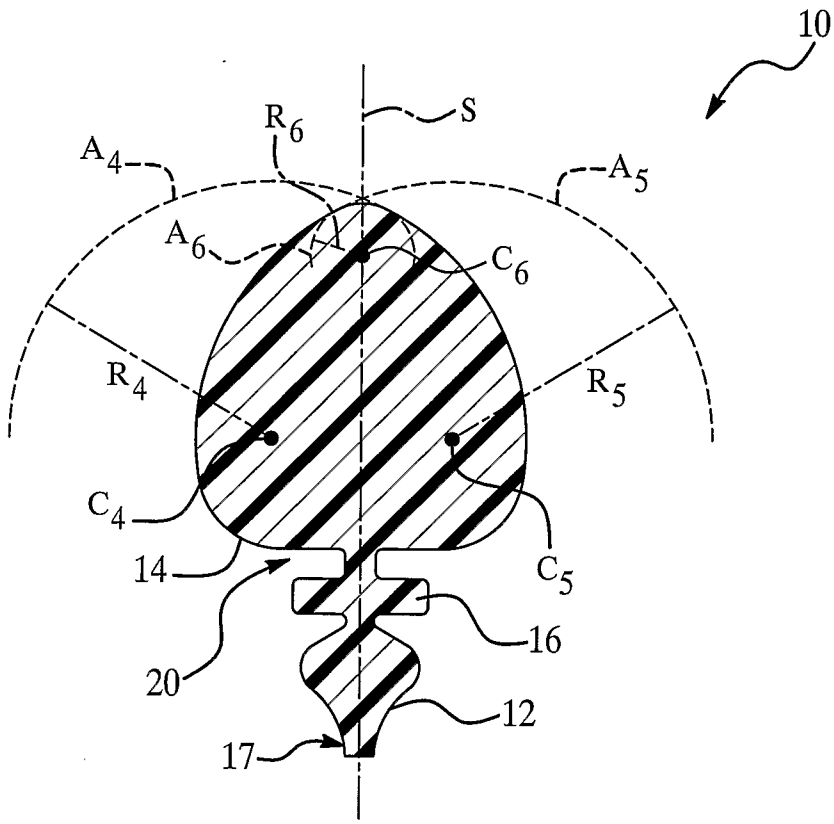


Figure 5

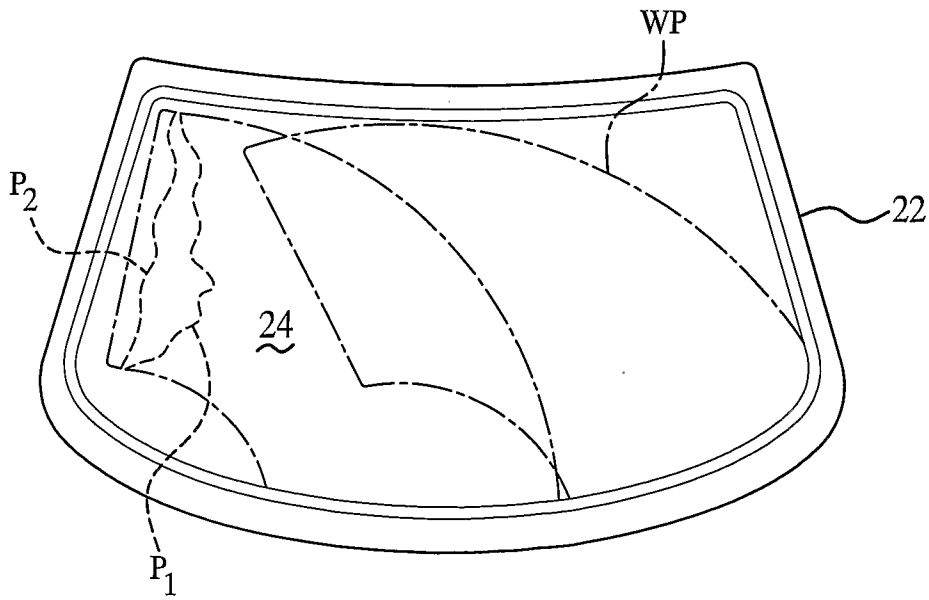


Figure 6

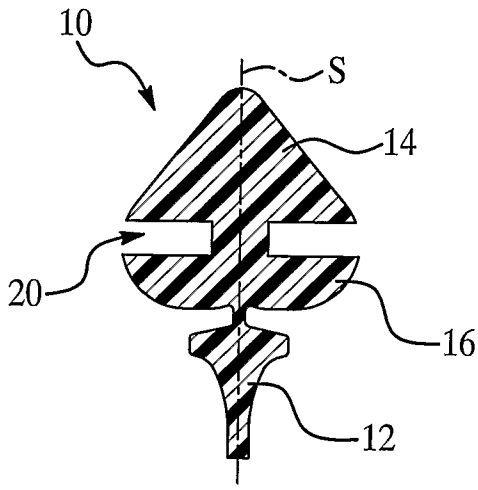


Figure 7A

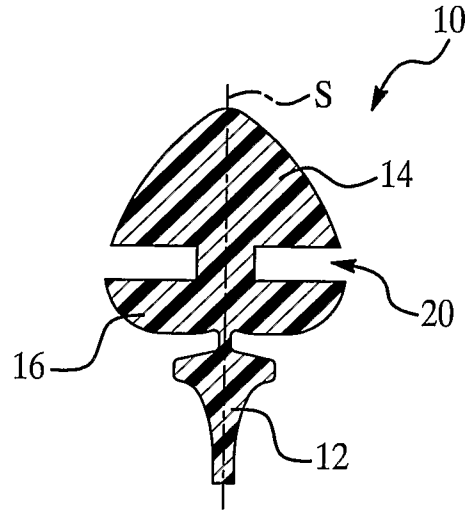


Figure 7B

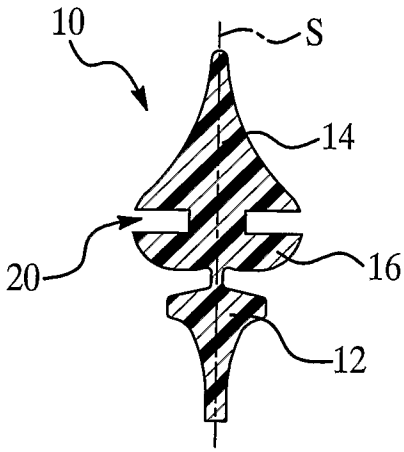


Figure 7C

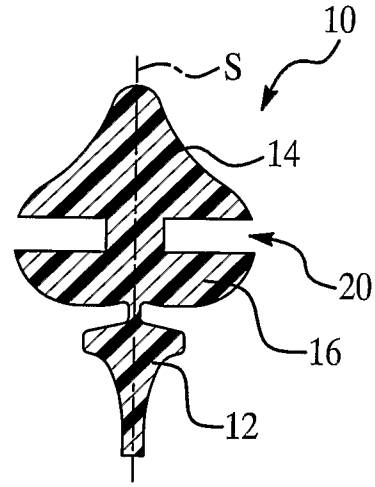


Figure 7D

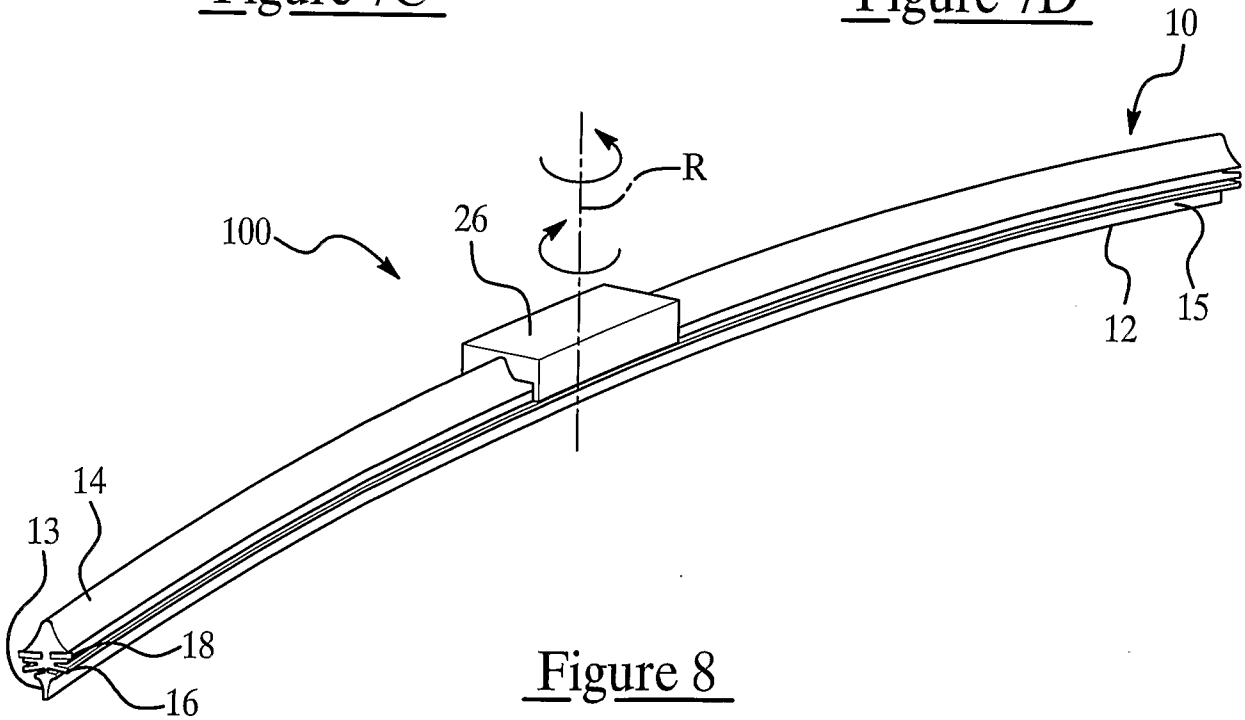


Figure 8

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2006/027996

A. CLASSIFICATION OF SUBJECT MATTER
INV. B60S1/38

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B60S

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
E	WO 2006/088808 A (TENNECO AUTOMOTIVE OPERATING C [US]; WALWORTH VAN T [US]; BOYLE MARK [) 24 August 2006 (2006-08-24) paragraph [0089] - paragraph [0108]; figures	1-7, 10-20, 23-28
X	DE 23 36 271 A1 (MAERZ GEORG) 6 February 1975 (1975-02-06) page 2, line 18 - page 3, line 17; figures	1-4, 12-17, 24-28
Y		9-11,22, 23

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
17 November 2006	27/11/2006

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Sangiorgi, Massimo

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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2006/027996

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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X	US 3 317 945 A (LUDWIG ARTHUR L) 9 May 1967 (1967-05-09) column 2, line 17 - column 5, line 7; figures	1-4, 12-17, 24-28
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A	abstract; figure 9	1,8
Y	EP 1 232 922 A2 (VOLKSWAGEN AG [DE]) 21 August 2002 (2002-08-21) paragraph [0014] - paragraph [0018]; figure	10,11,23
X	DE 100 25 630 A1 (VALEO AUTO ELECTRIC GMBH [DE]) 20 December 2001 (2001-12-20) paragraph [0034] - paragraph [0047]; figures	1-4,7, 14-17, 20,24-28
A	DE 299 03 123 U1 (BAEHR ALBERT [DE]) 15 July 1999 (1999-07-15) column 5, line 6 - column 8, line 13; figures	1,10,11, 23
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2006/027996

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