WIPER SYSTEM AND METHOD OF DEPLOYING THE SAME

FIELD OF THE INVENTION

The invention relates to a wiper system, in particular a wiper system for deployment on a vehicle with multiple windscreens, wherein each windscreen is arranged at an angle with respect to other windscreens.

BACKGROUND ART

The following discussion of the background to the invention is intended to facilitate an understanding of the present invention only. It should be appreciated that the discussion is not an acknowledgement or admission that any of the material referred to was published, known or part of the common general knowledge of the person skilled in the art in any jurisdiction as at the priority date of the invention.

Windscreens are deployed in vehicles to provide visibility to drivers and passengers. Wiper systems are installed to clean or wipe particles such as rain, dust, debris, etc. off the windscreens which can otherwise affect the visibility and compromise safety. Conventional windscreens are typically designed to have its surface generally flat or at most slightly curved, and therefore it is appreciable that the windscreen surface of conventional windscreen is typically planar. This allows for one wiper system to swipe across the whole windscreen surface easily.

Conventional wiper systems are based on a standard crank-rocker linkage system having one or more rubber wiper blades driven by a drive source such as a motor or engine to sweep across the surface of the windscreens to remove particles. The crank-rocker linkage system works to transform the rotary motion of the motor into an oscillating motion of the windscreen wiper(s). In multiple windscreens, provided that the windscreens lies substantially on the same plane, conventional wiper systems are able to easily adapted to be swiped across multiple windscreens.

However, in vehicles that deploy multiple windscreens where each windscreen arranged at a non-parallel angle with respect to other windscreens, and therefore not in the same plane, each of the multiple windscreens would typically require a separate and independent wiper system. As a simple example, a conventional three windscreen

arrangement/configuration would require three drive source (e.g. motors) with three sets of wipers. Such an arrangement may increase operation costs and lead to inefficiencies. In particular, as some of such multiple windscreens are deployed in military vehicles, any increase in form factor and space may add undesirable burden to the overall operational requirements and/or compromise key tactical advantages. In addition, due to manufacturing variances between motors, the oscillation phase/frequency between the multiple sets of wipers would be extremely difficult to synchronize. In some solutions, additional equipment to take into account planar differences between the windscreens may be required. Such additional equipment further add to cost, space, and weight.

In light of the above, there therefore exists a need to provide an improved wiper system for vehicles with multiple windscreens, each windscreen arranged at an angle with respect to other windscreens.

SUMMARY OF THE INVENTION

Throughout the specification, unless the context requires otherwise, the word "comprise" or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

Furthermore, throughout the specification, unless the context requires otherwise, the word "include" or variations such as "includes" or "including", will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

The invention provides for a technical solution wherein a plurality of windscreens, each windscreen arranged at an angle with respect to other windscreens, or a single windscreen having multiple surfaces or faces, each face arranged at an angle with respect to other faces, can be wiped by a wiper system driven by a single motor, this in spite of angular differences between the windscreen planes/faces.

The established paradigm for wiper control is to position the drive source (e.g. motor) and in the same plane as the driven elements (i.e. wiper assemblies). In other words, the axis of rotation of the drive source is parallel to the normal axis of the windscreen. This may be referred to as 'plane-matching'. While this works well in a single plane configuration, it can create a challenge in multiple windscreens or

windscreens having multiple faces, each windscreen/face lying in a different plane with respect to other windscreens/faces.

The inventors discovered that by driving the wiper system from a different plane with an offset of up to ninety (90) degrees, i.e. orthogonal from the multiple planes that is to be driven, the inventors were able to reduce the resources utilized for wiper control across the multiple windscreens.

In accordance with an aspect there is a wiper system comprising a drive source; a plurality of wiper modules adapted to be driven by the drive source; each wiper module configured for deployment on a surface; the plurality of wiper modules deployed in at least two planes, wherein the at least two planes are arranged at an obtuse angle with respect to each other; wherein the drive source is positioned such that the driving axis is offset with respect to the normal axes of the each of the at least two planes.

In some embodiments, the drive source is positioned such that the driving axis is offset between 45 degrees to 90 degrees with respect to the normal axes of each of the at least two surfaces. Preferably the driving axis is offset at or about 90 degrees.

In some embodiments, the drive source is positioned such that the driving axis is offset at 90 degrees or orthogonal with respect to the normal axes of each of the at least two surfaces.

In some embodiments, the drive source is a direct current (DC) motor.

In some embodiments, the drive source comprises a crank assembly.

In some embodiments, at least one of the wiper modules forms a crank rocker configuration with the crank assembly.

In accordance with another aspect there is a vehicle comprising a plurality of windscreens, each windscreen arranged at an angle with respect to another windscreen, the vehicle comprises a wiper system having a drive source; a plurality of wiper modules adapted to be driven by the drive source; each wiper module configured

for deployment on one of the plurality of windscreens; wherein the drive source is positioned such that the driving axis is offset with respect to the normal axes of the each of the plurality of windscreens.

In some embodiments, the single drive source of is positioned on the vehicle such that the driving axis is offset between 45 degrees to 90 degrees with respect to the normal axes of each of the plurality of windscreens.

In some embodiments, the single drive source is positioned such that the driving axis is offset at 90 degrees with respect to the normal axes of each of the plurality of windscreens.

In accordance with another aspect, there is a method for installing a wiper system on a plurality of windscreens, each windscreen arranged at an angle with respect to another windscreen, including the steps of:- a. providing a plurality of wiper modules, each wiper modules deployed on one of the plurality of windscreens; and b. arranging a single drive source to drive the plurality of wiper modules, the single drive source positioned such that the driving axis is offset with respect to the normal axes of the each of the plurality of windscreens.

In some embodiments, the step of arranging the single drive source includes positioning the single drive source such that the driving axis is offset between 45 degrees to 90 degrees with respect to the normal axes of each of the plurality of windscreens.

In some embodiments, the drive source is positioned such that the driving axis is offset at 90 degrees with respect to the normal axes of each of the plurality of windscreens.

BRIEF DESCRIPTION OF DRAWINGS

The present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Fig. 1 shows a wiper system deployed in a two-windscreen arrangement according to some embodiments of the invention;

Fig. 2 shows a wiper system and its constituent elements in a perspective view;

Fig. 3a to 3d shows a wiper system in operation for wiping two non-parallel planes, with the rotational axis of the motor and the oscillation axis of the wiper blades;

Fig. 4 illustrates an add-on module or wiper kit for an additional windscreen;

Fig. 5a to Fig. 5c show other possible embodiments of the wiper systems; and

Fig. 6 shows another embodiment of the crank assembly to translate the rotational force of a drive to oscillation motion of a wiper module.

Other arrangements of the invention are possible and, consequently, the accompanying drawing is not to be understood as superseding the generality of the preceding description of the invention.

DETAILED DESCRIPTION

In accordance with an aspect of the invention there is a wiper system, the wiper system includes a drive assembly and a plurality of wiper modules. The drive assembly comprises at least one drive source arranged to drive the plurality of wiper modules. Each wiper module comprise one or more wiper(s) for deployment and use on one windscreen or windscreen surface (also referred to as windscreen plane).

Referring to Fig. 1 and Fig. 2, there comprises a wiper system 100 that may be deployed on a vehicle having a plurality of windscreens, in particular two windscreens 102a, 102b. The two windscreens 102a, 102b are arranged at an angle α with respect to each other, where α is more than zero and less than one-hundred and eighty (180) degrees. Preferably, α is an obtuse angle. Therefore the windscreens 102a and 102b may be regarded as being in different planes with respect to one another. In the arrangement shown in Fig. 1, there comprises a single drive assembly 104 and two wiper modules 106 for the two windscreens 102a, 102b. The drive assembly 104 comprises a drive source 108, a drive crank assembly 110 and two connection arms 112, each connection arm 112 configured to connect the drive crank assembly 110 to one of the wiper module 106, assuming the one of the wiper module 106a is positioned to the one side of the drive crank assembly 110, and the other wiper module 106b is positioned to the other side of the drive crank assembly 110. The crank assembly 110

and connection arms 112 operate to translate the rotational force of the motor 108 to oscillation motion of each wiper module 106.

In some embodiments, the drive source 108 may be an electrical motor, such as a direct current (DC) motor.

Each wiper module 106 comprises a plurality of wiper blades 114 (usually formed from rubber) mounted onto corresponding wiper arms or frames 116. Each wiper frame or arm 116 is in turn connected to the connection arm 112 via a link 118. In operation, the link 118 is arranged to be moved towards and away from the drive assembly in a periodic manner corresponding to a periodic movement of the drive crank assembly 110.

In some embodiments, the drive crank assembly 110, together with the respective connection arm 112, and link 118 forms a four-bar linkage crank-rocker arrangement (or also known as a standard parallelogram 4-bar linkage mechanism).

In a preferred embodiment, the drive source 108 is positioned such that the rotational axis is orthogonal to the normal axis of the windscreen 102a and windscreen 102b. In operation, the rotational force of the motor shaft is transmitted to the crank assembly 110 which are in turn connected to each of the wiper module 106 via the connection arm 112. In summary, the orthogonal position of the motor 108 translates into a rotation vector being in plane with respect to each of the different planes of the windscreens 102a and 102b.

In operation, as the motor 108 turns, the drive crank assembly 110 is driven in a circular direction which causes a reciprocating motion, the reciprocating motion which in turn produces a lateral displacement on the connection arms 112. The lateral displacement causes the connection arm 112 to move to the wiper module 106 which then translates into a radial oscillation, causing the wiper to swipe across a pre-defined area on the windscreen (the amount of area depends on the length of wiper blade and the distance between the links 118 in each wiper module 106, amongst others).

It is appreciable that the arrangement where the motor 108 is positioned such that the rotational axis is orthogonal to the normal axis of the windscreens 102a and 102b is counter-intuitive because the driving motor 108 is deliberately offset with respect to the desired driven planes.

Fig. 3a to 3d are illustrations of the wiper system 100 in operation. Fig. 3a illustrates the direction of motor movement and rotation with respect to the oscillation of the wiper blades. With reference to Fig. 3b, the crank assembly 110 has a first link 302 having one end connected to the motor 108 (via a gear mechanism for example) and the other end connected to the connection arm 112a used to connect to wiper module 106a, and a second link 304 having one end connected to the connection arm 112a and the other end connected to the connection arm 112b used to connect another wiper module 106b. First link 302 and second link 304 may be metallic plates or rods. At this position shown in Fig. 3a, the wiper blades are positioned in a 'resting' state. The connection arms 112a and 112b are at a 'retracted state' and positioned almost on top of the respective first link 302 and second link 304 in a zig-zag manner.

As the motor 108 rotates in an anti-clockwise manner, the first link 302, which is akin to a crank pivoted about the motor, tracks the rotation of the motor 108 and rotates about the pivot (motor). Connection arm 112a, which is connected to the distal end of the first link 302 with respect to the pivot (motor), moves laterally. This causes the links 118 connected to the connection arm 112a at various points along the connection arm 112a to roll/rotate, which in turn causes the wiper blades 114 to sweep across an area of the windscreen. Simultaneously, the second link 304 also rotates about the pivot (motor) and the connection arm 112b moves laterally in an approximately opposite direction from connection arm 112a.

In some embodiments shown in Fig. 4, if there is an additional windscreen (i.e. a third windscreen) to be included in the system, the wiper system comprises an additional connection arm 412 and additional wiper module 406 to be attached to an existing connection arm 112. It is appreciable that the lateral displacement produced is then used to drive the newly introduced wiper module 406, as long as the subsequent windscreen is arranged at an angle within operational limits with respect to the 'parent windscreens' 102a, 102b.

In general, as more windscreens are added to the wiper system, the driving axis may be re-positioned such that it is orthogonal or near orthogonal with respect to the normal axes of the each of the plurality of windscreens. A minor non-orthogonal offset may still work, depending on the angle α between the plurality of windscreens.

In some embodiments, instead of repositioning the driving axis, adjustment devices such as rod-end bearings may be used to couple any new wiper modules deployed for additional windscreens or surfaces, to the existing wiper modules.

In some embodiments, the angle between the additional windscreen(s) with respect to the two windscreens 102a, 102b may be between 180 ± 15 degrees. In some embodiments, the angle between the additional windscreen(s) with respect to the two windscreens 102a, 102b may be up to between 180 ± 35 degrees.

Fig. 6 shows a close-up view of the drive crank assembly described in other embodiments. It may also form yet another embodiment.

The crank assembly 600 in the illustrated embodiment comprises a converter 602 and a plurality of crank shafts 604. The converter 602 is coupled to the drive source 108 to convert the rotation of the drive source 108 in a first plane to rotation of one or more crank shafts in a second plane. As shown in Fig. 6, the plane of rotation of the drive source 108 is about 90 degrees with respect to the plane of rotation of the crank shaft. Such an arrangement is advantageous to minimize the angular difference of any driving pins during movement of the crank shafts (and hence strain exerted on the driving pins).

The converter 602 may be one or more gear boxes having gear arrangement to convert the rotation of the drive source 108 to the rotation of the crank shafts 604 as known to a skilled person.

The plurality of crank shafts 604 comprise a first crank shaft 604a and a second crank shaft 604b. It is appreciable that the plurality of crank shafts 604 may correspond to the links 302, 304 as illustrated in Fig. 3.

The first crank shaft 604a comprises two ends. One end of the first crank shaft 604a is connected to the converter 602, and the point of connection is operable to be the center of rotation where the first crank shaft 604a is rotatable about.

The other end of the first crank shaft 604a is attachable to a first connection arm 112a via a first driving pin 606. It is appreciable that a first end of the first driving pin 606 is attached to the other end of the first crank shaft 604a.

When attached, the length of the first driving pin 606 forms a height h_1 extending from the first crank shaft 604a. The length h_1 can range from 19 millimeters (mm) to 73 mm.

One end of the first connection arm 112a is attachable to the first driving pin 606. The other end of the first connection arm 112a is attachable to a wiper module. The connection arm is attached to a body portion of the first driving pin 606.

A second crank shaft 604b is attached to a second end of the first driving pin 606 which is distal from the first crank shaft 604a.

A second driving pin 612 extends from the second crank shaft 604b. When attached, the length of the second driving pin 612 forms a height h_2 extending from the second crank shaft 604b. The length h_2 can range from 18mm to 68mm.

One end of a second connection arm 112b is attachable to the second driving pin 612. The other end of the second connection arm 112b is attachable to a wiper module. The second connection arm 112b is attachable to a body portion of the second driving pin 606.

In operation, the first driving pin 606 and the second driving pin 612 will move within separate areas/volumes to actuate the respective modified crank-rocker arrangement which in turn move the wiper modules. These are labeled as 'volume 1' and 'volume 2' in Fig. 6.

The first connection arm 112a and the second connection arm 112b are connected to the respective wiper modules using first driven pin 620a and second driven pin 620b.

In operation, if the wiper oscillation vector is at an angle with respect to the rotation vector of the drive source 108, the first and second driven pins 620a, 620b may experience a small amount of height displacement (and a larger lateral displacement) during the course of one oscillation cycle of the crank shafts, where one oscillation may be defined as a complete rotation of the first crank shaft 604a about its center of rotation. The crank assembly 600 has been designed to allow minimal angular differences between the respective rod-end bearings throughout one oscillation cycle. This is in part due to the consideration of the height h_1 and h_2 and the positioning of the drive source to minimize the angular difference for any driving/driven pins, which may be rod-end

bearings. Said reduction of angles is achieved by the fact that the orthogonal position of the motor will result in the rotational vector being parallel to the different planes of the windscreens.

Either the first driving pin 606, the second driving pin 612, or both the first driving pin 606 and second driving pin 612 may be rod-end bearings.

The technical objective seeks to minimize the angular difference for the rod-end bearings. Said reduction of angles is achieved by the fact that the orthogonal position of the motor means that the rotational vector is parallel to both planes. It is to be appreciated that by having all the wiper planes to be driven by a single motor, cost is reduced, space is saved, the system is more energy efficient, reliability is improved and all wipers are able to maintain oscillation phase/frequency with respect to each other.

The use of a crank-rocker style system to translate a rotational locus into an oscillation. The use of a standard drive source, the standard parallelogram 4-Bar linkage of a radial wiper system for each linkage group (per windscreen).

Besides in vehicles, the described embodiments can be applied to vehicles/facilities requiring multiple non parallel window/windscreen surfaces to be cleaned/wiped.

It may be appreciable that in general any add-on wiper link planes cannot deviate too far off from its parent planes. In other words, the angle between subsequent add-on wiper planes with respect to the two windscreens 102a, 102b for wiping additional windscreen(s) or surface(s) should preferably allow the wipers to perform its function of oscillating and cleaning the additional windscreens or surfaces, otherwise the excessive deviation may cause interference or reduce/remove its ability to oscillate the wiper blades.

In some embodiments as shown in Fig. 5, where it is not possible for the motor 108 to be positioned such that the drive direction is in an orthogonal axis with respect to the normal axis of the windscreen planes, a different arrangement is contemplated. In particular, a gear system 520 comprising a plurality of compensating gears 530, typically bevel gears, are mechanically linked to the drive motor 508 in order to create multiple in-axis rotary outputs for the multiple windscreens/ planes. In some

embodiments, rod-end bearings may be used to take up the angular difference (very limited angular deviation allowed).

In some embodiments, as the drive source 108 is offset further from the orthogonal position, the more the rod-end bearings may be required to cater for any angular difference between the wiper planes.

The described embodiments may be suited for aerospace and defence applications. In some embodiments, the wiper system may be applied to an aviation control tower having multiple glass viewing panels, each glass panel arranged in an angle with respect to other glass panels. It is envisaged that a single drive source may possibly drive multiple wiper modules deployed around the control tower.

In some embodiments, the wiper systems may be applied to a marine vessel such as a ship or submarine having multiple windscreens/viewing windows arranged at different angles with respect to each other.

In yet other embodiments, the wiper systems can be deployed in aircrafts having multiple windscreens/viewing windows arranged at different angles with respect to each other.

It is appreciable that the position of the drive source and the offset of the driving axis will be affected by windscreen size, length, width, depth and width of wiper system, locus of drive crank assembly etc.

In general, the main advantages of this system would lend itself for applications where space and weight are at a premium and having an angled windscreen can make a difference. Moreover, the system is also more reliable and cheaper due to reduced bill of materials (BOM) and that can make the invention an attractive option for those using multiple wiper modules. Unlike traditional wiper systems where a standard crank-rocker style linkage system is driven along the normal axis of the wiping plane by a motor, the wiper system 100 changes the primary driving axis approximately orthogonal to the normal axis of two (2) different planes, and drives a modified crank rocker system where the driving plane is not in plane with the driven links.

It is to be appreciated that while the invention is suitable for deployment in a multiple windscreen environment, it is appreciable that the invention can be deployed in the context of a single windscreen having multiple faces.

It is to be appreciated that while rod-end bearings are utilized in various embodiments, other types of mechanical articulating joints to provide 90 degree alignment between the attached shaft and the second component may be used. Examples include clevis fasteners.

It is to be appreciated that reference to any angles in the description is not limited strictly to the actual angle stated but may include deviations from the angles to allow the invention to still work. For example, the term '90 degrees' or 'orthogonal' may refer to 90 ± 5 degrees.

It is to be appreciated that features from various embodiment(s), not being expressed in alternatives, may be combined to form one or more additional embodiments.

CLAIMS

1. A wiper system comprising

a drive source;

a plurality of wiper modules adapted to be driven by the drive source; each wiper module configured for deployment on a surface; the plurality of wiper modules deployed in at least two planes, wherein the at least two planes are arranged at an obtuse angle with respect to each other; wherein the drive source is positioned such that the driving axis is offset between 45 degrees to 90 degrees with respect to the normal axes of the each of the at least two planes.

2. The wiper system according to claim 1, wherein the drive source is positioned such that the driving axis is offset at 90 degrees with respect to the normal axes of each of the at least two planes.

3. The wiper system according to any one of the preceding claims, wherein the drive source is a DC motor.

4. The wiper system according to claim 1, wherein the drive source comprises a crank assembly.

5. The wiper system according to claim 4, wherein at least one of the wiper modules forms a crank rocker configuration with the crank assembly.

6. The wiper system according to claim 4, further comprises at least one rod-end bearing positioned between the crank assembly and one of the plurality of wiper modules.

7. A vehicle comprising a plurality of windscreens, each windscreen arranged at an angle with respect to another windscreen, the vehicle comprises a wiper system having

a drive source;

a plurality of wiper modules adapted to be driven by the drive source; each wiper module configured for deployment on one of the plurality of windscreens; wherein the drive source is positioned such that the driving axis is offset between 45 degrees to 90 degrees with respect to the normal axes of each of the plurality of windscreens.

8. The vehicle according to claim 7, wherein the single drive source is positioned such that the driving axis is offset at 90 degrees with respect to the normal axes of each of the plurality of windscreens.

9. A method for installing a wiper system on a plurality of windscreens, each windscreen arranged at an angle with respect to another windscreen, including the steps of:-

a. providing a plurality of wiper modules, each wiper modules deployed on one of the plurality of windscreens; and

b. arranging a single drive source to drive the plurality of wiper modules, the single drive source positioned such that the driving axis is offset between 45 degrees to 90 degrees with respect to the normal axes of the each of the plurality of windscreens.

10. The method according to claim 9, wherein the drive source is positioned such that the driving axis is offset at 90 degrees with respect to the normal axes of each of the plurality of windscreens.