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Publish Patent Application: 1 247 161   Filing Ref.: A 43139 II/63 c

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FEDERAL REPUBLIC OF GERMANY

GERMAN PATENT OFFICE

PUBLISHED PATENT APPLICATION

1 247 161

Int. Cl.: B 62 d
B 08 b; B 60 j; B 60 s

German Cl.: **63** c – **82**

Number: 1 247 161
Filing Ref.: A 43139 II/63 c
Application date: May 18, 1963
Publication date: August 10, 1967

Windshield wiper, particularly for motor vehicles

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Priority:
USA, May 21, 1962 (196 254) - -

The invention relates to windshield wipers, particularly for a motor vehicle, having a spring-elastic wiper blade which consists of a bendable spring rail, the same being attached approximately at the center of the wiper arm and having a cross-section which is lesser toward the ends thereof, and having a rubber wiping element or the like, and being curved in the same direction as the windshield, but more highly.

Windshield wipers are known for use on curved windshields, having wiper blades made of rubber and loosely attached on two brackets each, which in turn are linked to a bracket, wherein the actuating arm engages with the center thereof. A spring rail serves the purpose of attaching the wiper blade to the two brackets, wherein the wiper blade is slid into said spring rail, the same being curved in the same or opposite direction as the windshield in order to enable an improved contact between the wiper blade and the curved windshield. By way of example, pull springs also serve this purpose, arranged between the brackets, in order to particularly be able to pull the ends of the wiper blade against the windshield surface. In addition, the width of the spring rails used to hold the wiper blade has been tapered toward the ends in order to give the ends a more bendable construction and enable better contact. However, these measures have proven insufficient because the arrangement of the brackets results particularly in a comparably high rigidity of the ends of the wiper blade. In addition, the manufacture of these known windshield wipers requires a comparably large number of individual parts, wherein specialized machines are required for the assembly thereof. In addition, the constructed height is comparably large as a result of the brackets, such that the wipers tend to lift under strong headwinds, since the wind meets a comparably large lateral surface of engagement.

Furthermore, windshield wipers are known for curved windshields in which the wiper arm is linked approximately in the center directly to the wiper. This makes it possible to dispense with a considerable number of individual parts. However, precautions must be taken to produce the most even possible contact between the wiper and the windshield. For this purpose, a configuration is known, by way of example, wherein coil-shaped springs made of rubber are arranged on the reverse side of the wiper blade, wherein the elasticity thereof is supposed to press the wiper blade against the windshield. However, it is not possible even in this case to achieve an even surface-pressure by the wiper blade against the windshield, even if the curvature of the blade when unstressed is less than the curvature of the windshield.

In another known design, the pressure distribution, as well as the flexibility, of the ends of the wiper blade is improved by a second, shorter spring rail being placed over a spring rail to which the wiper blade is attached. The point of engagement of the wiper arm is approximately in the center of the wiper blade. The two spring rails likewise have a curvature when unstressed which is less than the windshield curvature, and are configured with a rubber covering. However, this results in a compromising of the free movement of the two spring rails with respect to each other. In addition, this known cross-section tapering of the spring rail from the point of engagement of the wiper arm to the ends does not make an even contact pressure per unit area possible.

The problem addressed by the invention is therefore that of designing a windshield wiper, with the least possible constructive complexity, in such a manner that the contact pressure per unit area of the wiper blade against the windshield is constant.

According to the invention, this problem is addressed for a windshield wiper of the type named above in that, for the purpose of achieving a constant contact pressure per unit area of the wiper blade against the windshield, the radius of curvature of the spring rail when unstressed, the cross-section tapering which proceeds from the point of engagement of the wiper arm toward both ends, as well as the elastic modulus of the materials of the spring rail, are tuned to each other, according to the length, in such a manner that the spring constant increases from the ends to the point of engagement of the wiper arm as the fourth power of the distance from the ends.

The windshield wiper according to the invention therefore only has one single spring rail to which the wiper blade is attached. In addition, there is a holder attached to the spring rail, the wiper arm engaging with said holder. It is possible to manufacture the spring rail, and assemble the wiper, in a particularly simple manner. In addition, the windshield wiper according to the invention has a very low constructed height, such that the configuration prevents lifting in strong headwinds, even with the common pressing forces of the wiper arm in the order of magnitude of approximately 11 g/cm of the blade length. In contrast to the known windshield wiper with brackets, ice and snow which are deposited on the windshield are not able to hinder this windshield wiper.

The invention is based on the thinking that the contact pressure of the wiper blade against the windshield, in a wiper with a point of engagement lying approximately in the center of the wiper arm, is constant if the spring constant of the spring rail increases from the ends to the point of engagement of the wiper arm as the fourth power of the distance from the ends. As such, the spring constant changes parabolically.

In one advantageous embodiment of the invention, the width of the spring rail narrows towards the ends parabolically. In a further advantageous embodiment, however, the thickness of the spring rail can decrease continuously towards the ends. Further embodiments of the invention are characterized in the remaining dependent claims.

Multiple embodiments of the invention are described in greater detail below with reference to the drawings, wherein:

Figs. 1a to 1c show an illustration as an explanation of the invention,

Figs. 2a to 2c show a first embodiment of the spring rail with variable width,

Figs. 3a to 3c show a second embodiment of the spring rail with variable thickness,

Fig. 4 shows a top view of a wiper blade with a spring rail according to Fig. 2,

Fig. 5 shows a side view of the wiper blade according to Fig. 4,

Fig. 6 shows a cutaway view along the line 6-6 in Fig. 4,

Fig. 7 shows a cutaway view through a spring rail according to Fig. 2, with an adhesively bonded wiper blade, and

Fig. 8 shows a cutaway view through a spring rail according to Fig. 3, with a wiper blade glued on.

The approach of providing substantially uniform pressure by means of a single spring rail may best be understood by first considering the conditions which would produce uniform pressure on a flat windshield surface. With reference to Figs. la – lc, uniform pressure load along the length of a spring rail **20** having uniform width **21** and uniform thickness **22** could be achieved by the spring rail being configured with an appropriate parabolic shape when unstressed, this shape having its principal axis perpendicular to a tangent in the point of engagement of the wiper arm of the spring rail. When the spring rail moves perpendicular to a flat windshield surface **25**, the ends **26** would to produce [*sic*] initial contact with progressive correspondence of the shape of the spring and that of the windshield from the ends toward the center as shown in Figs. 1b and 1c. The parabolic shape when unstressed, said shape being required for completely uniform distribution of pressure for a given total central loading *P* at the point of engagement of the wiper arm, depends on the length, thickness, width and elastic modulus of the material used. For a given elastic modulus, relatively thinner or narrower segments will require relatively greater deflection and a deeper parabolic shape to produce a given uniform pressure load.

As illustrated in Figs. 2a – 2c, the longitudinal section when unstressed has a tapering of the width **27** *a* of the spring rail **27** from a maximum at the point of engagement **29** of the wiper arm to a minimum at the ends **28** for the purpose of producing a uniform load distribution, and this tapering has the shape of parabolic arcs having their principal axes perpendicular to the ends **28** of the spring rails **27** (see Fig. 4, spring rail **36** and ends **39**). The curvature of the spring rail **27** when unstressed is then no longer parabolic as in Fig. 1, but rather has the shape of a circular arc such that the spring rail **27** again comes into contact against the windshield **29** beginning with the ends **28** and, with increasing pressure load on the point of engagement **29** of the wiper, toward the same, as shown in Figs. 2b and 2c. When fully flattened, the bending stress as well as the unit pressure load of the spring rail **27** is uniform throughout, in contrast to the previously discussed uniform width parabolic shape of the spring element where the bending stress is non-uniform and has its maximum value at the point of engagement of the wiper arm.

Figs. 3a – 3c show that a similar result can be achieved by providing a uniform width **31** of spring **32** which has a uniformly tapered thickness **33** from a maximum at the point of engagement **34** of the wiper arm to a minimum at each end **35** in which case a circular arc curvature again results in uniformly progressive “adaptation” from the ends **35** to the point of engagement **34** of the wiper arm when uniform pressure contact is exerted along the length of the spring rail **32** from a load *P* applied to the point of engagement **34** of the wiper arm, as illustrated in Figs. 3b and 3c.

The effect of this taper can also be produced by using spring stock of uniform thickness having a reinforcing rib or ribs (not shown) of progressively increasing depth from the ends to the point of engagement of the wiper arm, formed parallel to the longitudinal center line of the spring rail; or flanges (not shown) of tapering depth from the ends may be formed at the edges of the spring rail to provide progressively increasing resistance to bending from the ends to the point of engagement of the wiper arm.

Obviously, it is also possible to combine in a number of different ways these various constructional approaches to provide a single spring rail having uniform pressure load characteristics when pressed against a flat windshield. Whichever construction is used, it is the combination of the flexible rubber wiper blade and a spring rail which determines the final pressure characteristic between the wiper blade and the windshield surface. For this reason the shape and cross-section of the flexible rubber wiper blade must also be taken into account, in addition to the spring rail, in determining the proper design proportions.

As a result of the parabolic tapering of the spring rail width according to Fig. 2, and/or the uniform tapering of the spring rail thickness according to Fig. 3, the spring constant increases – substantially as the fourth power of the distance from the ends – from the ends toward the point of engagement of the wiper arm. If the spring rail is configured with ribs or flanges, this criterion must also be fulfilled. Then the contact pressure of the wiper blade against the windshield is constant. In other words, the bending moment of the spring rail increases from the ends toward the point of engagement of the wiper arm as the fourth power of the distance from each end.

For curved windshields, it is possible to achieve a substantially uniform pressure load by adding the additional curve of the curved windshield surface to the curvature which produces a uniform pressure load on a flat surface. In this manner a single spring rail provides uniform pressure on any average or extreme curvature surface or intermediate curvature portion of a variable windshield surface. If the wiper is required to operate over a substantially variable curvature region, a fully uniform pressure can be provided for only one specific curvature, wherein the wiper arm exerts a fixed, pre-determined total pressure load, yet variations in pressure are minimized in several ways such that the wiper functions in a completely satisfactory manner. One way is to adopt a uniform pressure curve intermediate to the extremities of maximum and minimum curvature contours traversed by the wiper; another is to employ a spring material having a high modulus of elasticity and high fatigue strength combined with a high degree of unstressed curvature for the desired total loading, such that the spring constant forms a minimum and the variations in the curvature of the windshield are a minimal fraction of the total deflection. The spring constant is the ratio of load to deflection.

According to Figs. 4 – 6, a spring rail **36** of the type illustrated in Figs. 2a – 2c can carry a known rubber wiper blade **37** by having a slot **38** extending almost throughout the length and terminating just short of the end **39**, for the purpose of accommodating a flanged rib **40** of the wiper blade **37** projecting through the same. The sides of the spring rail **36** can be sprung apart to enable the attachment of the wiper blade before the attachment clip **41** *a* of the wiper arm is secured thereto by rivets **42** providing a permanent assembly for retaining the wiper blade **37** in position. As shown in the illustration in Fig. 5, the spring rail **36** *a* and rubber wiper **37** *a* have a circular arc shape when unstressed which provides a uniform contact pressure along the length of contact with a flat windshield **43** when fully depressed by the wiper arm (not shown).

Figure **7** shows a modification in the detailed construction of the rubber wiper blade and the attaching means, wherein a spring rail **45** with a design similar to that of Figs. 4 – 6 has a wiper blade **46** which is attached by adhesive bonding at **47** in the known manner. The modification of Fig. 8 shows a wiper blade **48** similarly attached by adhesive bonding at **49** to a spring rail **50** of reduced thickness as shown in Figs. 3a – 3c.

Claims:

1. A windshield wiper, particularly for motor vehicles, having a spring-elastic wiper blade which consists of a bendable spring rail, wherein the wiper arm is attached approximately at the center thereof, said spring rail having a cross-section which tapers toward the ends thereof, and having a rubber wiping element or the like, the windshield wiper being curved in the same direction as the windshield, but more highly, characterized in that, for the purpose of achieving a constant contact pressure per unit area of the wiper blade against the windshield, the radius of curvature of the spring rail (**27**, **32**, **36**) when unstressed, the cross-section tapering which proceeds from the point of engagement (**29**, **34**, **41**) of the wiper arm toward both ends, as well as the elastic modulus of the materials of the spring rail, are tuned to each other, according to the length, in such a manner that the spring constant increases from the ends to the point of engagement of the wiper arm as the fourth power of the distance from the ends.

2. A windshield wiper according to claim 1, characterized in that the width (**27** *a*) of the spring rail (**27**) tapers parabolically toward the ends (**28**).

3. A windshield wiper according to claim 1, characterized in that the thickness (**33**) of the spring rail (**32**) tapers continuously toward the ends (**35**).

4. A windshield wiper according to claims 1 to 3, characterized in that the rigidity of the spring rail can be modified in known ways by ribs or flanges.

5. A windshield wiper according to claims 1 to 4, characterized in that the curvature of the spring rail when unstressed has the shape of a circular arc.

References cited:
French patents nos.: 820 156, 1 033 521, 1 039 421, 1 124 116, 1 145 640, 1 217 680;
British patent no. 593 775.

DRAWINGS PAGE 1

Number: **1 247 161**
Int. Cl.: B **62** d
German Cl.: **63** c – **82**
Publication date: August 10, 1967

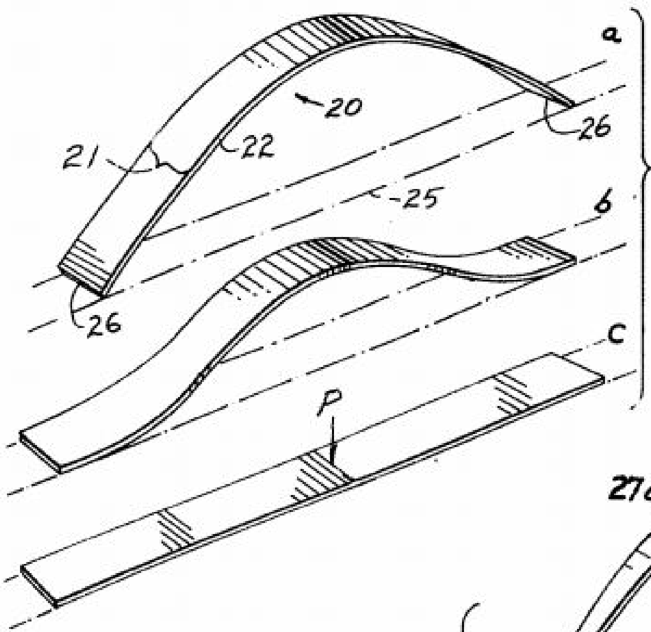
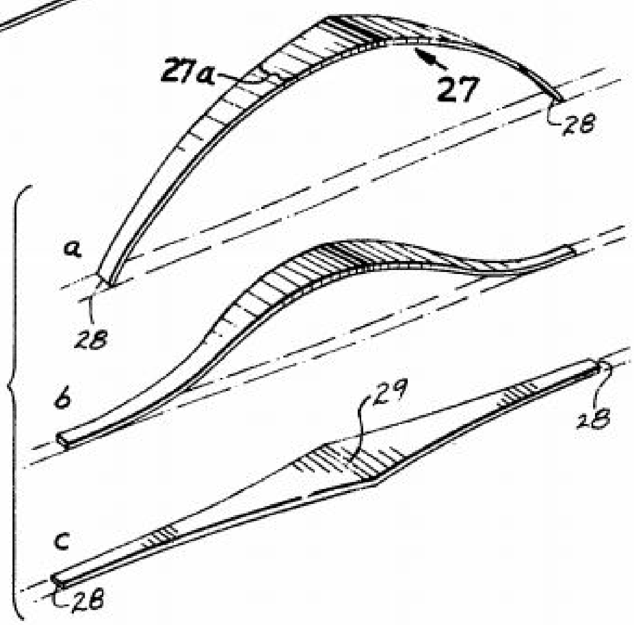


FIG. 1

FIG. 2



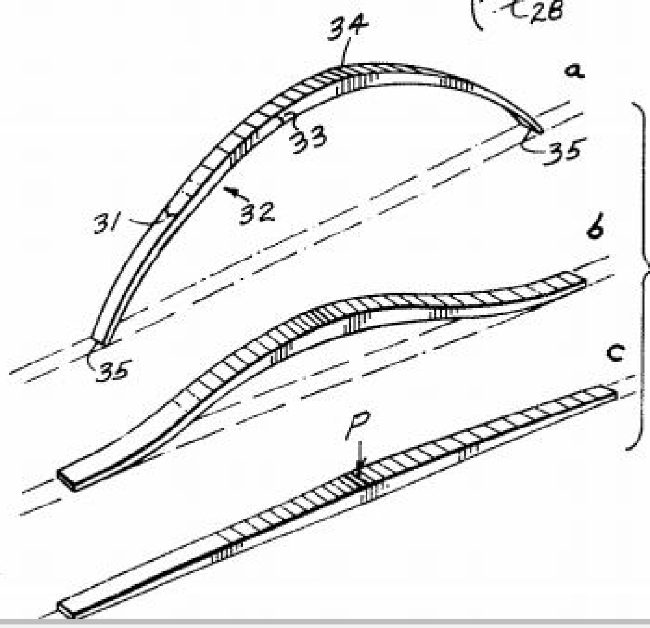


FIG. 3

DOCKET ALARM

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