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# United States Patent [19]

**Swanepoel**

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[45] **Date of Patent: Jul. 5, 1994**

[54] **WINDSCREEN WIPER BLADE WITH CURVED BACKING MEMBER**

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[21] Appl. No.: **167,615**

[22] Filed: **Dec. 15, 1993**

**Related U.S. Application Data**

[63] Continuation of Ser. No. 928,981, Aug. 12, 1992, abandoned.

[30] **Foreign Application Priority Data**

Aug. 16, 1991 [ZA] South Africa ........................ 91/6473
Jan. 17, 1992 [ZA] South Africa ........................ 92/0354

[51] **Int. Cl.**5 ................................................ **B60S 1/38**
[52] **U.S. Cl.** ............................... **15/250.42;** 15/250.36
[58] **Field of Search** ........... 15/250.42, 250.36, 250.20, 15/250.002, 250.41, 250.40, 250.37, 250.38, 250.39, 250.001; D12/155

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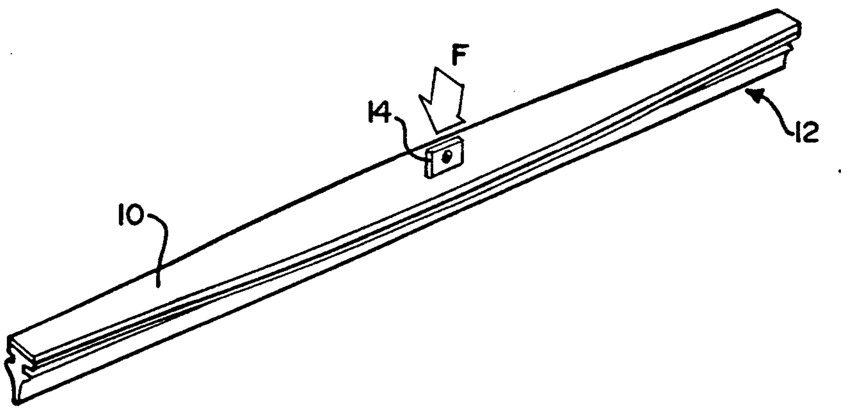
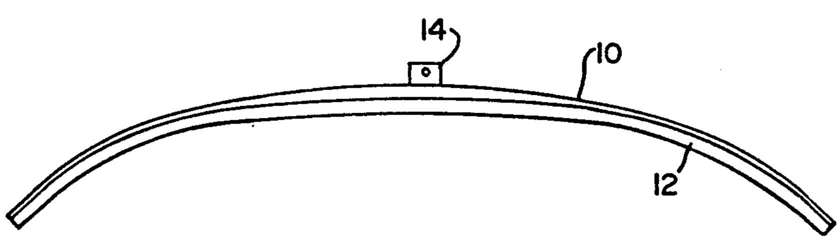
*Assistant Examiner*—Gary K. Graham
*Attorney, Agent, or Firm*—Cushman, Darby & Cushman

[57] **ABSTRACT**

A curved elongate backbone for a windscreen wiper has a loading profile that increases substantially from a central connector towards one or both ends of the backbone. The second differential of the bending moment also increases substantially from the connector towards the ends. The loading may increase right to the ends of the backbone or the backbone may have end portions with constant loading. In order to obtain the desired loading profile the width, thickness and free-form radius of curvature are suitably selected. In preferred embodiments, the backbone has a rectangular cross-sectional profile and the thickness and width decrease uniformly from the connector to the ends. However the thickness may also be constant for end portions.

**16 Claims, 3 Drawing Sheets**



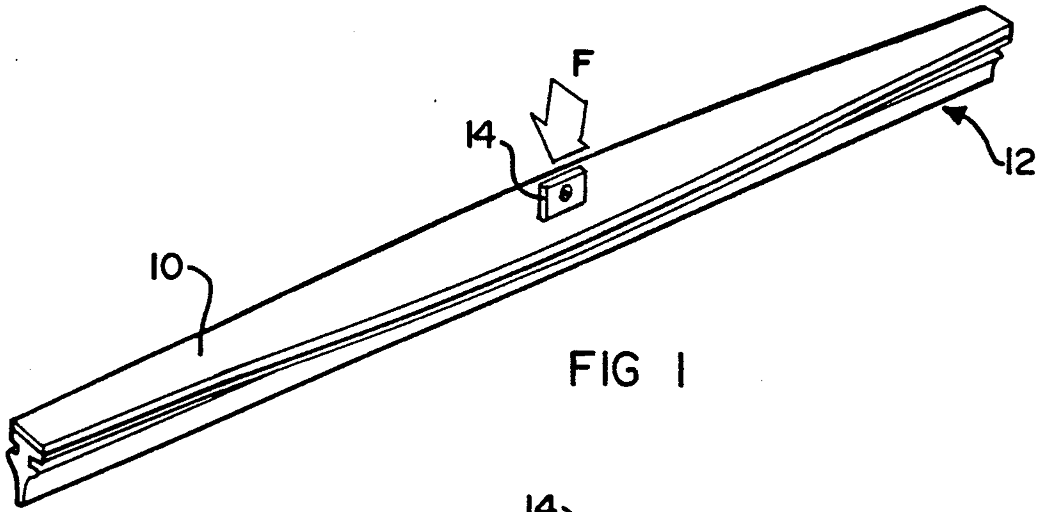



FIG 1

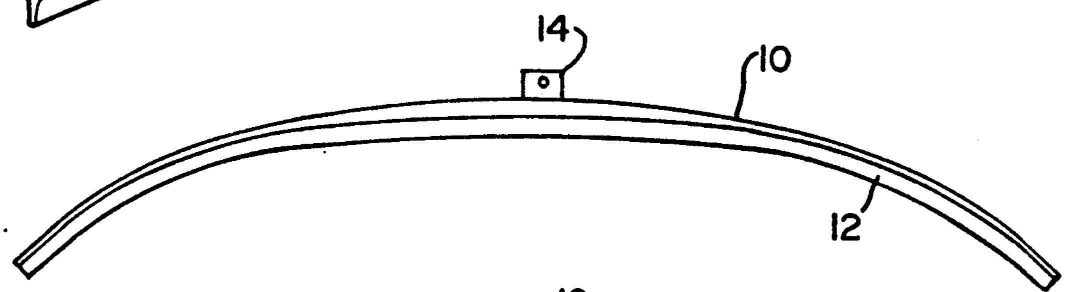



FIG 2

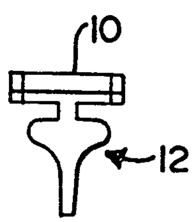



FIG 3

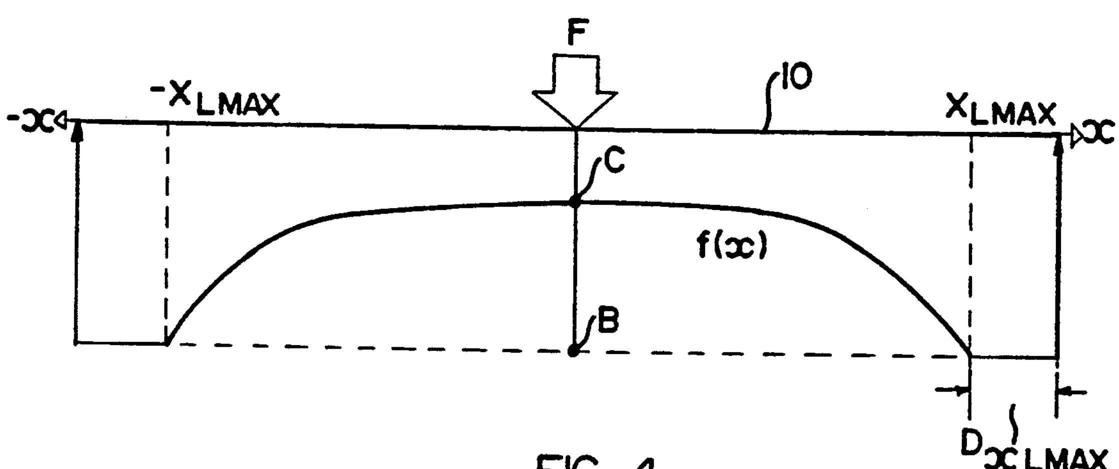



FIG 4

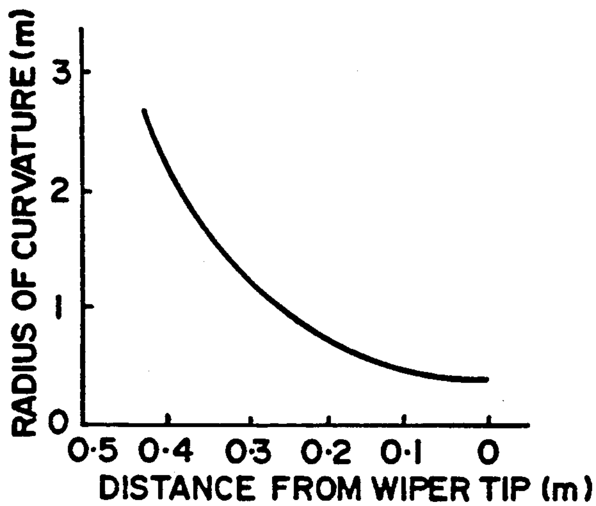

RADIUS OF CURVATURE (m)
3
2
1
0
0·5 0·4 0·3 0·2 0·1 0
DISTANCE FROM WIPER TIP (m)

FIG 5

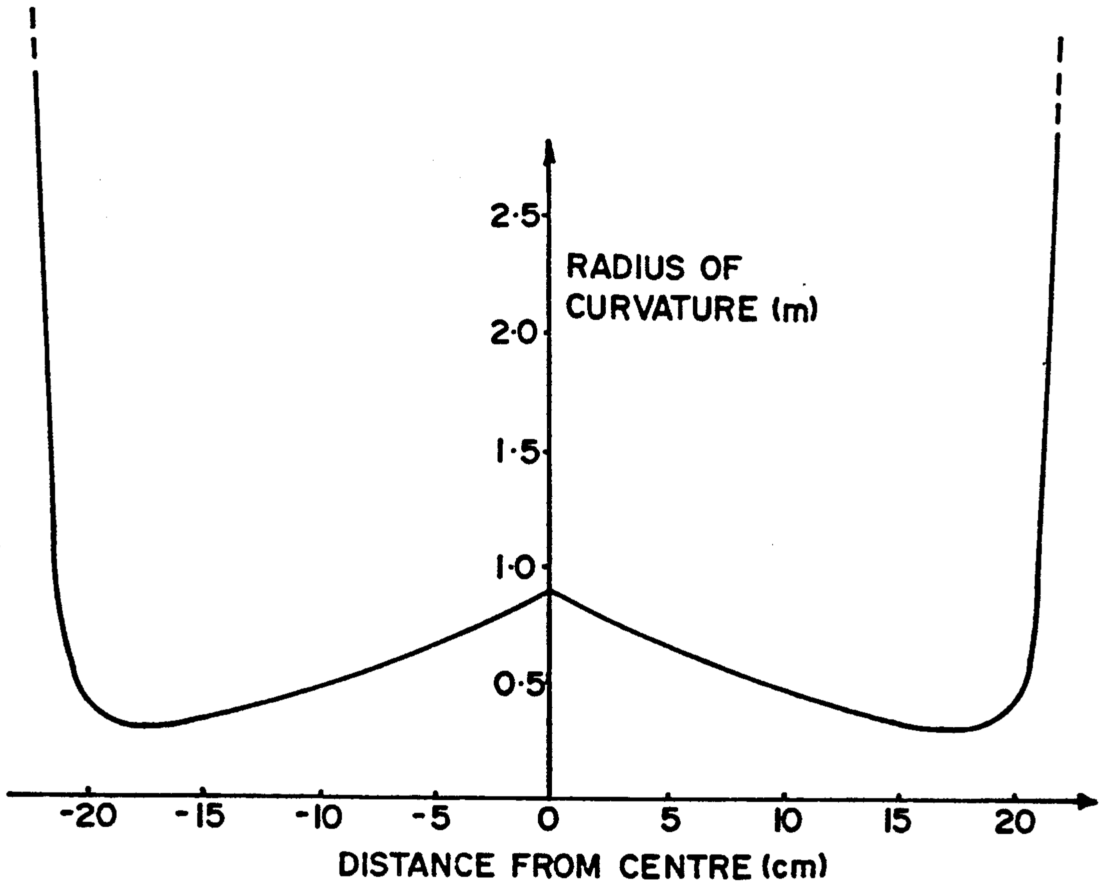

2·5
2·0
1·5
1·0
0·5
RADIUS OF CURVATURE (m)
-20 -15 -10 -5 0 5 10 15 20
DISTANCE FROM CENTRE (cm)

FIG 6

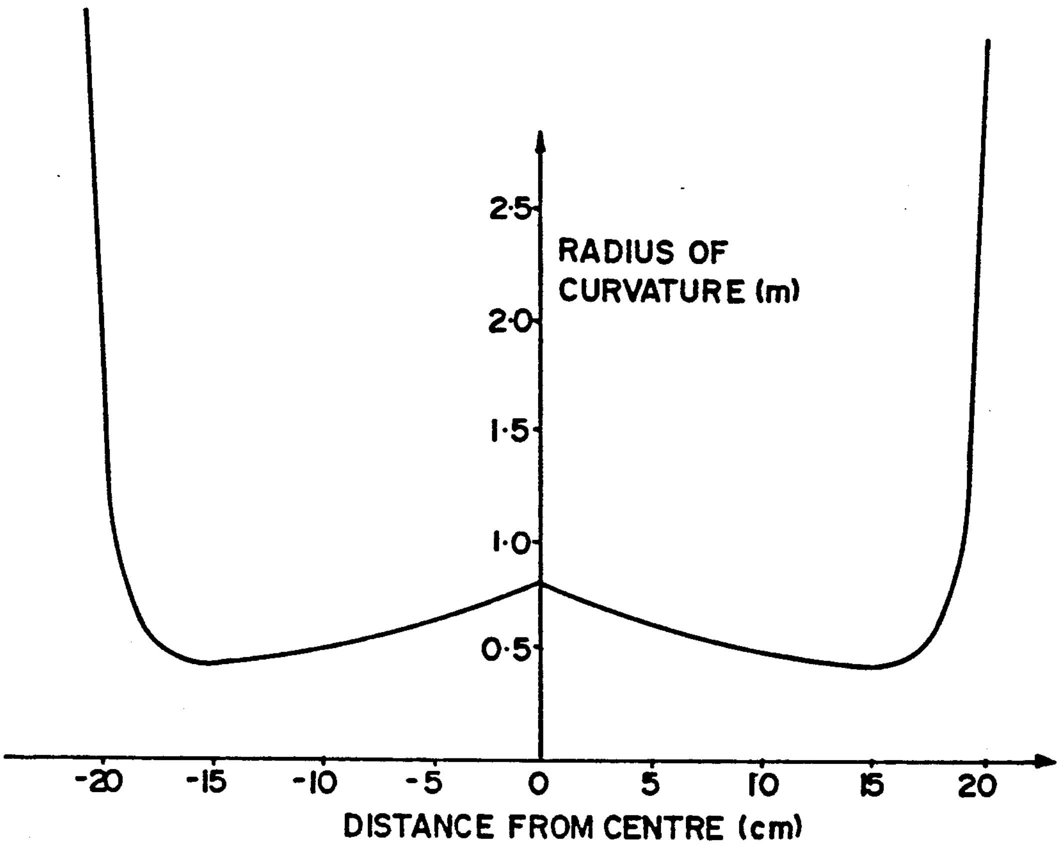
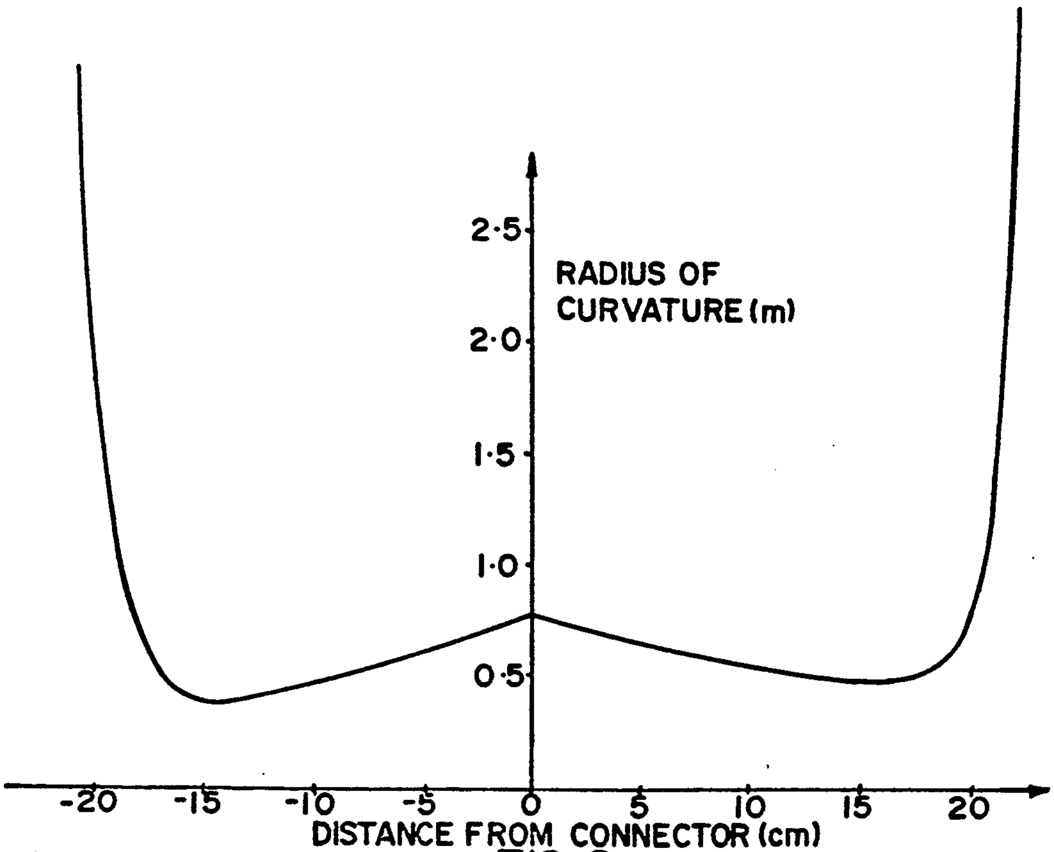

2·5
2·0
1·5
1·0
0·5
RADIUS OF CURVATURE (m)
-20 -15 -10 -5 0 5 10 15 20
DISTANCE FROM CENTRE (cm)

FIG 7


2·5
2·0
1·5
1·0
0·5
RADIUS OF CURVATURE (m)
-20 -15 -10 -5 0 5 10 15 20
DISTANCE FROM CONNECTOR (cm)

## WINDSCREEN WIPER BLADE WITH CURVED BACKING MEMBER

This is a continuation of application Ser. No. 07/928,981, filed on Aug. 12, 1992, which was abandoned upon the filing hereof.

### BACKGROUND OF THE INVENTION

This invention relates to a windscreen wiper and more particularly to an elongate curved backbone for a windscreen wiper which is of a suitably resiliently flexible material.

### SUMMARY OF THE INVENTION

According to the invention there is provided a windscreen wiper which includes an elongate curved backbone which is of a resiliently flexible material and which has a connecting formation at a position intermediate its length for connection to a displacing and force applying member, the backbone having a suitably varying transverse cross-sectional profile along its length and a suitable free-form curvature for the backbone to achieve, when it is pressed downwardly at the connecting formation onto a flat surface by a force sufficient to straighten the backbone, a force per unit length exerted perpendicularly to the surface which increases substantially from the position of the connecting formation towards at least one end of the backbone.

The backbone may be curved in a plane- the plane of curvature.

Further according to the invention there is provided a windscreen wiper which includes an elongate backbone which is curved in a plane, which is of a resiliently flexible material and which has a connecting formation at a position intermediate its length for connection to a displacing and force applying member, the backbone having a suitably varying cross-sectional profile along its length and a suitable free-form curvature, such that the second differential of the function M(x) increases substantially from the said position towards at least one end of the backbone, where

$$M(x) = \frac{E * I(x)}{R(x)}$$

with

E=modulus of elasticity

I(x)=cross-section moment of inertia of the backbone about a neutral axis transverse to the plane of curvature, at a distance x from the said position; and

R(x)=free-form radius of curvature of the backbone in the plane of curvature at x.

The wiper may include a wiper blade attached to the backbone and the sufficient force referred to above may be that force which causes the blade to contact the surface in a straight operative manner.

Persons skilled in the art will appreciate that the backbone will have a concave side and a convex side, the wider blade being attached to the concave side and the displacing and force applying member on the convex side.

The backbone may conveniently be of a metal such as spring steel and may be in the form of a single strip or may be in the form of a laminate.

The connecting formation may be centrally located or the wiper may be assymetric. The force per unit length may increase towards only one end of the backbone, but preferably it increases towards both ends of



the backbone. Further, the force per unit length may increase towards both ends in a similar or dissimilar manner. Similarly, the second differential of M(x) may increase substantially from the connecting formation towards only one end or towards both ends. If it increases towards both ends this may be in a substantially similar or dissimilar manner.

The force per unit length and the second differential of M(x) may increase progressively towards the ends of the backbone until a short distance from each end and the backbone may then have two small portions at each end where the force per unit length and the second differential are a constant value. Further, the backbone may be such that in these small portions the force per unit length and the second differential are constant right to the tips of the backbone, or, at tip regions the backbone may be such that the force per unit length and the second differential decrease from the constant value to zero at the extremities of the backbone.

The force per unit length may increase, at least in the central region of the backbone, in an exponential manner. Conveniently,

$$f(x)=A|x|^n+C$$

where

f(x)=force per unit length at a distance x from the connecting formation,

A and C are determinable constants, and

n is greater than unity.

Conveniently, n may be at least 3, is least 6 and is preferably about 10.

Those skilled in the art will appreciate that I (x) is determined by the transverse dimensions of the backbone at any position along its length. In most cases, the backbone will have a regular cross-sectional profile which may, for example be rectangular or ellipsoidal. Thus, in most instances, the backbone will have a width and a thickness. It will be understood that the width dimension will be that dimension which extends perpendicularly to the plane of curvature and the thickness will be the dimension which lies in the plane of curvature.

The thickness of the backbone may decrease from the connecting formation towards both ends until a predetermined distance from the ends, with the thickness being constant along these end portions. These end portions may have a length of at least 20 mm.

It can be shown, that with a backbone which has a rectilinear cross-section at all positions along its length, that

$$M(x) = \frac{E * b_x * h_x^3}{12 * R_x}$$

where

$b_x$ equals the width at distance x,

$h_x$ equals thickness at distance x.

Thus, with a backbone having a rectangular cross-section, the width and thickness may vary in a predetermined manner and the radius of curvature may then be varied so that M(x), and mrs second differential vary in the desired manner.

If the backbone has an elliptical cross-section then it can be shown that

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