Nov. 24, 1970 R. V. ZAWODNIAK 3,543,272

ANTENNA WINDSHIELD HAVING A SINGLE CONTINUOUS ANTENNA WIRE

Filed Nov. 6, 1968 2 Sheets-Sheet 1

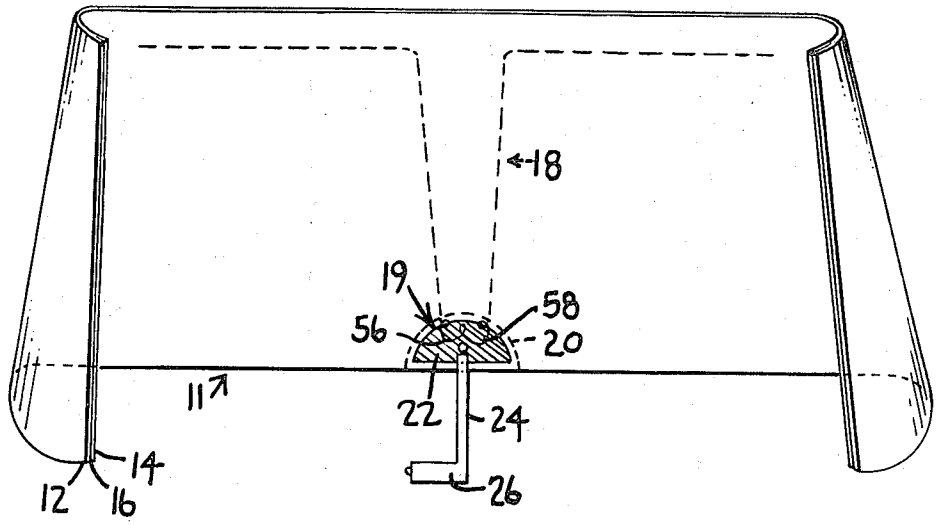


FIG. 1

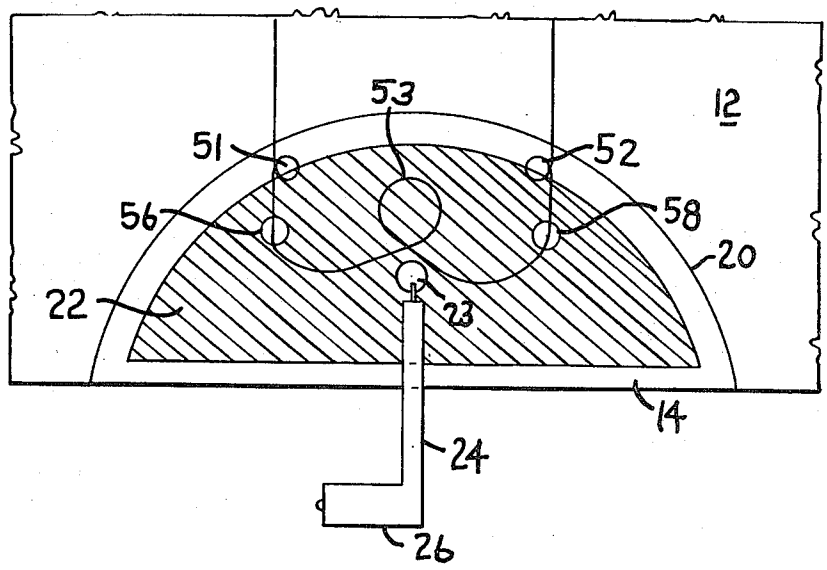


FIG. 2

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ANTENNA WINDSHIELD HAVING A SINGLE CONTINUOUS ANTENNA WIRE

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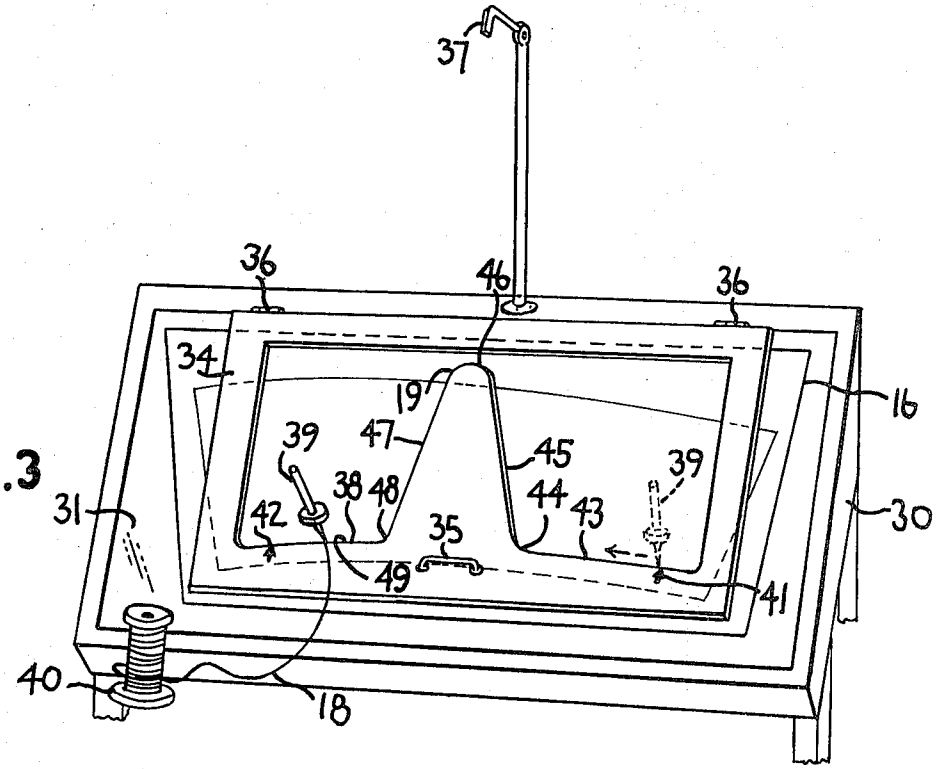


FIG. 3

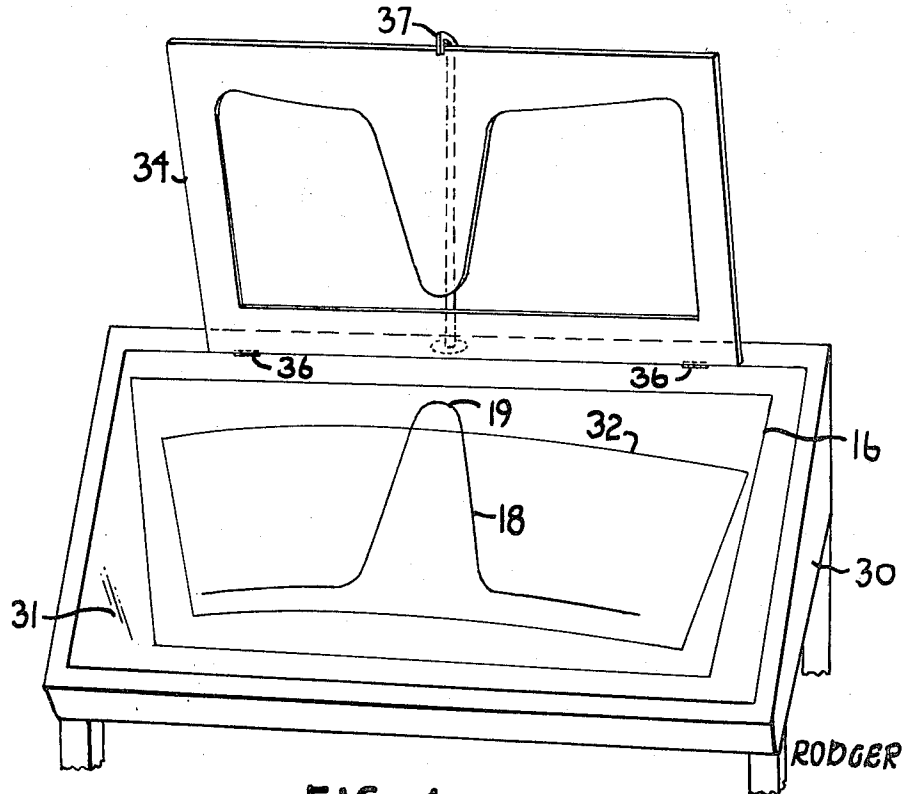


FIG. 4

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3,543,272

ANTENNA WINDSHIELD HAVING A SINGLE CONTINUOUS ANTENNA WIRE

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Int. Cl. H01q 1/32, 1/40
U.S. Cl. 343—713 10 Claims

ABSTRACT OF THE DISCLOSURE

An improved antenna for a laminated windshield comprising a single continuous antenna wire mounted in a plastic interlayer and having its central portion exposed for two spaced electrical connections to a metal tab electrically connected to a radio receiver. The wire portion between each electrical connection is loose as are the wire portions between each electrical connection and the wire portions mounted in the interlayer.

This invention concerns an antenna windshield. Prior to the present invention, the automobile industry developed laminated windshields comprising a pair of matched glass sheets laminated to opposite sides of a plastic interlayer in which a plurality of electroconductive wires are embedded in the plastic interlayer to serve as an antenna for a radio installed in the vehicle. The embedded wires were each connected to a common conductor plate that is in turn connected to the radio receiver.

Using the laminated windshield to support the antenna has improved the styling of automobiles by eliminating the whip antenna that extended from the vehicle body. Its use has also avoided a source of vandalism—the snapping of the antenna from the automobile.

Since automobile windshields require a lot of handling before they are installed in an automobile, it is very likely that as many as 10 percent of antenna windshields have electrical connections that become damaged from the time the windshields are assembled in a fabrication plant to the time the windshields are installed in an automobile. It is necessary to have the wires embedded within the windshield to extend substantially the full height and substantially the full length of the windshield to provide an antenna substantially equal in performance to the performance of the conventional whip antenna in its fully extended position. Therefore, any failure of an electrical connection of one or more of the antenna wires to the common plate or tab attached to the lead-in wire for the radio receiver causes the antenna to function in an inefficient manner.

The present invention provides an arrangement of antenna wire such that antenna failure is virtually eliminated even though an electrical connection between the antenna wire and the common plate electrically connected to the radio receiver is broken.

The above objective of the present invention is accomplished by utilizing a single continuous electroconductive wire mounted in the plastic interlayer of a laminated windshield with the central portion of the wire extending outside of the interlayer. A pair of spaced electrical connections connect linearly spaced portions of the central portion of the single, continuous antenna wire outside said interlayer to a metal tab electrically connected to the radio receiver in such a manner that loose lengths of said wire are disposed between said pair of electrical connections and also between each of said pair of electrical connections and the portion of said continuous wire that enters the interlayer.

The present invention will be understood more clearly in the light of a description of a particular embodiment which follows.

In the drawings forming part of the description of the illustrative embodiment, and wherein like reference numbers refer to like structural elements;

FIG. 1 is a fragmentary, perspective view of an antenna windshield conforming to the present invention looking at the windshield from within a vehicle;

FIG. 2 is an enlarged view of a critical portion of said windshield depicted in FIG. 1 looking at the windshield portion from outside the vehicle; and

FIGS. 3 and 4 are overhead, oblique views of apparatus used to embed a single continuous wire in a plastic interlayer, showing the relation of the apparatus elements to one another during and after a wire embedding operation, respectively.

Referring to the drawings, reference number 11 refers to a laminated windshield comprising an outer glass sheet 12, an inner glass sheet 14 of matching curvature and an interlayer 16 of thermoplastic material, preferably plasticized polyvinyl butyral, which is commonly found in present day commercial windshields. In the usual automotive windshield, the outer and inner glass sheets 12 and 14 respectively are curved and have an outline conforming to the windshield frame in which the laminated windshield is installed. An elongated wire 18 is embedded within the interlayer 16 except for a central portion 19 which extends beyond the outline of the interlayer sheet for folding into a notched portion 20 along a longitudinal lower side edge of the outer glass sheet 12.

The wire 18 is preferably a 36 gauge copper wire encased in an enamel sheath and has a maximum diameter of .005 inch so as to be virtually invisible to an occupant. It is arranged in the laminated windshield in symmetrical arrangement relative to an axis extending transversely across the mid-point of the windshield.

A metal tab 22, preferably a thin shim of copper about 10 mils thick conected at 23 to a lead-in wire 24 which terminates in a plug 26, is inserted within the notched portion of the outer glass sheet 12. The lead-in wire 24 is insulated except for its extremity portion that is connected to the metal tab 22 to which it is securely welded or soldered or otherwise securely fastened sufficiently strongly to withstand a pull of more than 25 pounds without failure.

The interlayer sheet 16 has the wire 18 embedded therein by using the apparatus depicted in FIGS. 3 and 4. The apparatus is supported on top of table 30, which preferably supports an illuminated transparent glass sheet 31. A pattern 32 conforming to the outline of the plastic inter-layer after the latter is trimmed to conform to the outline of glass sheets 12 and 14 is marked along the under surface of the glass sheet 31 to guide an operator in placing an untrimmed plastic sheet 16 in proper position on the table. A pivotal frame 34 having a handle 35 is mounted for rotation relative to the table about a pivotal axis defined by a pair of hinges 36. The table 30 supports a pivoted hook 37 that engages the frame when the latter is in an upwardly retracted position. The frame 34 contains a template 38 along the inner edge of its margin, which template serves as a guide for a path for moving a heated needle 39 through which thin wire is fed from a spool 40.

The template 38 extends from a first indicator mark 41 denoting its origin to a second indicator mark 42 that denotes its terminal. The template 38 extends from the first indicator mark 41 along a first path 43 extending generally lengthwise of the frame and then curves at a concave corner 44 into a transverse path 45 that extends beyond the outline guide 32 that defines the position of

an elongated edge of a properly aligned interlayer sheet **16** to a turn around guide **46**. The template continues along a transverse path **47** to another concave corner **48** and another linear path **49** that extends longitudinally of the frame **34** to the second indicator mark **42**. The latter indicates where the wire should be cut.

An untrimmed sheet **16** of plasticized polyvinyl butyral is mounted on the table **30** over the glass sheet **31** in proper registration with its margin disposed beyond the pattern or outline guide **32**. The frame is released from hook **37** and pivoted over the table and the needle **39** moved along the template **38** to imbed the wire **18** into the sheet **16**. The heat of the needle causes the wire fed through the needle **39** as the latter traverses the template **38** to penetrate into the sheet of interlayer material along a line extending from mark **41** to mark **42** along a path conforming to the shape of the template so that substantially the entire length of the wire except for its central portion **19** is embedded within the trimmed interlayer and the portion **19** forms a loop exterior to the interlayer. In order to accomplish this end, an operator lifts the needle **39** from the sheet **16** as it approaches the turnaround guide **46** and reimbeds the needle **39** into the sheet after the latter has completed its turn around the turnaround guide **46** and started to move along transverse path **47**. A cam (not shown) may be provided around the turnaround guide **46** to control the movement of the needle out of and into the plastic sheet **16**.

In forming the laminated antenna windshield, a pair of glass sheets of matching outline is mounted on a bending mold of outline configuration and concave elevation and the glass is heated sufficiently to sag onto the shaping surface. A suitable parting material, such as a suspension of finely divided diatomaceous earth in water, is applied to the interfacial surface between the two sheets to prevent the sheets from fusing together during the bending operation. After the sheets are bent, they are cooled at a controlled rate while still supported on the bending mold and then removed from the mold when cool enough to handle.

The sheets of plastic containing the embedded wire are stored in a room of controlled temperature and humidity until they are ready for lamination between a pair of bent glass sheets of matching curvature. The bent pair of matching glass sheets are then separated from one another. The unnotched glass sheet **14** is mounted with its concave surface downward over a support of convex elevation. The plastic sheet is then inserted over the glass sheet **14** that is not notched and the notched glass sheet **12** aligned over the plastic sheet **16**. The plastic sheet is trimmed with the loop **19** of exposed wire **18** carefully held to prevent its being cut during the plastic trimming operation. The glass-plastic assembly so formed is prepressed and laminated following conventional commercial practice. A preferred prepressing apparatus used is described and claimed in U.S. Pat. No. 3,351,001 to Anthony A. Achkio, assigned to PPG Industries, Inc.

The prepressed assemblies are then laminated in autoclaves at a temperature of about 275 degrees Fahrenheit and a pressure of about 225 pounds per square inch for about 45 minutes.

After prepressing and before final lamination, a shim **22** of a highly conductive metal such as copper having a lead-in wire **24** and a plug **26** for a radio receiver attached thereto is pressed against the portion of the interlayer sheet **16** that faces the notched portion **20** of notched sheet **12**. The central portion of the wire is then folded to form a pair of relaxed portions **51** and **52** and additionally twisted to form loop **53** intermediate the two relaxed portions **51** and **52** so that the entire central portion **19** of the wire **18** fits within the notched portion **20** of the sheet **12** that lies over the interlayer sheet **16**. The wire **18** is then electrically connected to the metal tab **22** at a solder or welding connection **56** which is intermediate relaxed portion **51** and loop **53** and at another solder or welding connection **58** which is intermediate relaxed portion **52** and loop **53**.

The electric circuit so formed is then tested. The plug **26** is inserted in a testing circuit for this test. This indicates whether a signal from the embedded wire will reach a radio circuit in sufficient strength to provide adequate reception.

The assembly is mounted on a rack with the notched portion **20** facing upward and masking tape applied to the unnotched sheet **14** in its portion aligned with and slightly beyond each end of the notched portion **20**.

An adhesive tape such as a polyurethane tape is then applied to the edge surfaces of the glass sheets to form a wall for the chamber formed by the notched portion **20** in the sheet **12**. A suitable fast setting electrical insulating material, such as a fast setting polysulfide resin sold under the trade name "Thiokol" by the Thiokol Chemical Company of Bristol, Pa. or a room temperature vulcanizable silicone such as 615 RTV silicone supplied by the General Electric Company, Schenectady, N.Y. or Scotchcast 225 electrical resin sold by the Minnesota Mining and Manufacturing Company, St. Paul, Minn., is injection molded into the recess **20**.

The masking tape is removed, leaving only the polyurethane tape wall enclosing the injection molded material in the notched portion **20**. The assembly is then stored with other assemblies for sufficient time for the injection molded material to harden. Then the assembly is ready for the aforesaid lamination.

Relaxing the antenna wire in its central portion **19** provides flexibility for the antenna wire **18**. This flexibility reduces the likelihood that the antenna wire would pull away from the electrical connections **56** and **58** in case of faulty electrical connections during fabrication, rough handling during final lamination, storage, shipment to an automobile assembly plant and/or handling in its final assembly into an automobile frame. However, even if the antenna wire were not made more flexible, the breaking of one of the electrical connections **56** or **58** would not end the functioning of the embedded wire **18** as an antenna, because the other electrical connection that remains unbroken provides a continuous circuit connection from the radio receiver to the entire length of the antenna wire **18**. In the past, the breaking of any electrical connection caused the loss of the particular wire attached to the broken connection and hence reduced the efficiency of the multiple wire antenna typical of the prior art.

Prior to the present invention, approximately 10 percent of the antenna windshields which passed the final test for continuous circuit after assembly were found to be deficient after they were installed in an automobile frame. These antenna windshields subject to such failure frequency comprised two separate antenna wires each separately soldered to the metal tab **22**. Changing the structure of the antenna windshield to the present embodiment comprising a single continuous antenna wire soldered to the metal tab at two spaced locations with sufficient flexibility of the antenna wire between the electrical connections and also between each of the electrical connections and the point of embedding into the interlayer has resulted in a virtual elimination of these losses.

The form of the invention shown and described in this disclosure represents an illustrative embodiment thereof. It is understood that various changes, such as changes in materials of the interlayer, wire, tab and glass sheet compositions and manner of attachment of the wire to the tab, for example, may be made without departing from the spirit of the invention as defined in the claimed subject matter that follows.

What is claimed is:

1. In a laminated antenna windshield comprising a pair of matched glass sheets, one of which is notched to provide a notched portion along one of its longitudinal side edges to receive a metal tab electrically connected to a radio receiver, a plastic interlayer bonded between said sheets

and electroconductive wire mounted in said plastic interlayer for use as a radio antenna for said raido receiver, said metal tab being bonded to said interlayer in said notched portion, the improvement wherein said antenna wire consists of a single continuous wire substantially symmetrically arranged with respect to said laminated windshield with the central portion of said wire outside of said interlayer, and a pair of spaced electrical connections connecting linearly spaced portions of the central portion of said wire outside said interlayer to said metal tab leaving loose lengths of said wire between said electrical connections and also between each of said electrical connections and the portions of said wire mounted in said interlayer.

2. The improvement as in claim **1**, wherein said wire is looped between said electrical connections.

3. The improvement according to claim **1**, wherein said wire is looped between each portion thereof mounted in said interlayer and each of said electrical connections.

4. The improvement as in claim **1**, wherein said entire central portion fits within said notched portion and electrical insulating material is disposed within said notched portion.

5. The improvement as in claim **4**, wherein said electrical insulating material is composed of a polysulfide resin.

6. The improvement as in claim **4**, further including a wall of tape enclosing said notched portion to form a wall of a chamber enclosing said entire central portion and said electrical insulating material.

7. A laminated antenna windshield comprising a pair of glass sheets of matching curvature, a plastic interlayer sheet laminated between said pair of glass sheets, a single continuous wire mounted within said interlayer and having a relaxed central portion outside said interlayer, a metal tab within the outline of said laminated windshield, and a pair of spaced electrical connections connecting linearly spaced portions of the central portion of said wire outside said interlayer to said metal tab leaving loose lengths of said wire between said electrical connections and also between each of said electrical connections and the portions of said wire mounted in said interlayer.

8. A laminated antenna windshield as in claim **7**, wherein said relaxed central portion of said wire is embedded in electrical insulating material.

9. A laminated windshield as in claim **8**, wherein said electrical insulating material is composed of a polysulfide resin.

10. A laminated windshield as in claim **8**, further including a wall of tape enclosing said relaxed central portion of said wire and said electrical insulating material outside said interlayer and within the outline of said windshield.

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PAUL L. GENSLER, Primary Examiner

U.S. Cl. X.R.

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