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[54] **VEHICLE FUEL INJECTOR AND CARBURETOR UNIT**

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[63] Continuation-in-part of Ser. No. 216,361, Jan. 10, 1972, Pat. No. 3,814,391.

[52] **U.S. Cl.** .... **261/144,** 123/122 AC, 123/135, 48/180 H, 261/50 R, 261/78 R

[51] **Int. Cl.** **F02m 29/04**

[58] **Field of Search** .... 261/50 R, 144, 78 R; 48/180 R, 180 H, 180 B; 123/122 AC, 122 R, 135

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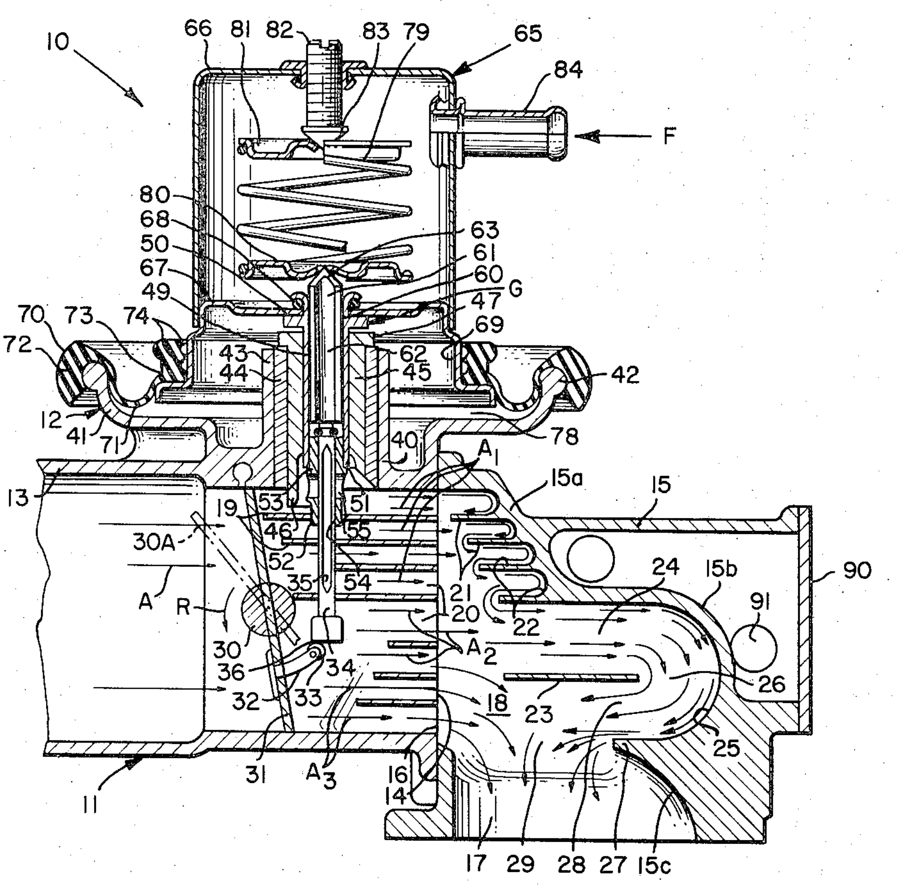
[57] **ABSTRACT**

Ambient air is split by parallel guide plates into streams of in-rushing air, some of which drives fuel from a metering valve into a mixing chamber. Some fuel is carried into pockets defined by fins formed by the interior walls of an upper section of a main housing. After being mixed in the pockets and in gaps between the pockets and guide plates, the air-fuel flow is forced into an elongated U-shaped channel defined in part by a divider plate. The direction of flow is reversed by the U-shaped channel and the air-fuel flow is then routed into a turbulent encounter with other streams of air in a contraflow collision zone. Thereafter, the thoroughly mixed air-fuel flow is diverted through an outlet into a manifold.

9 Claims, 1 Drawing Figure



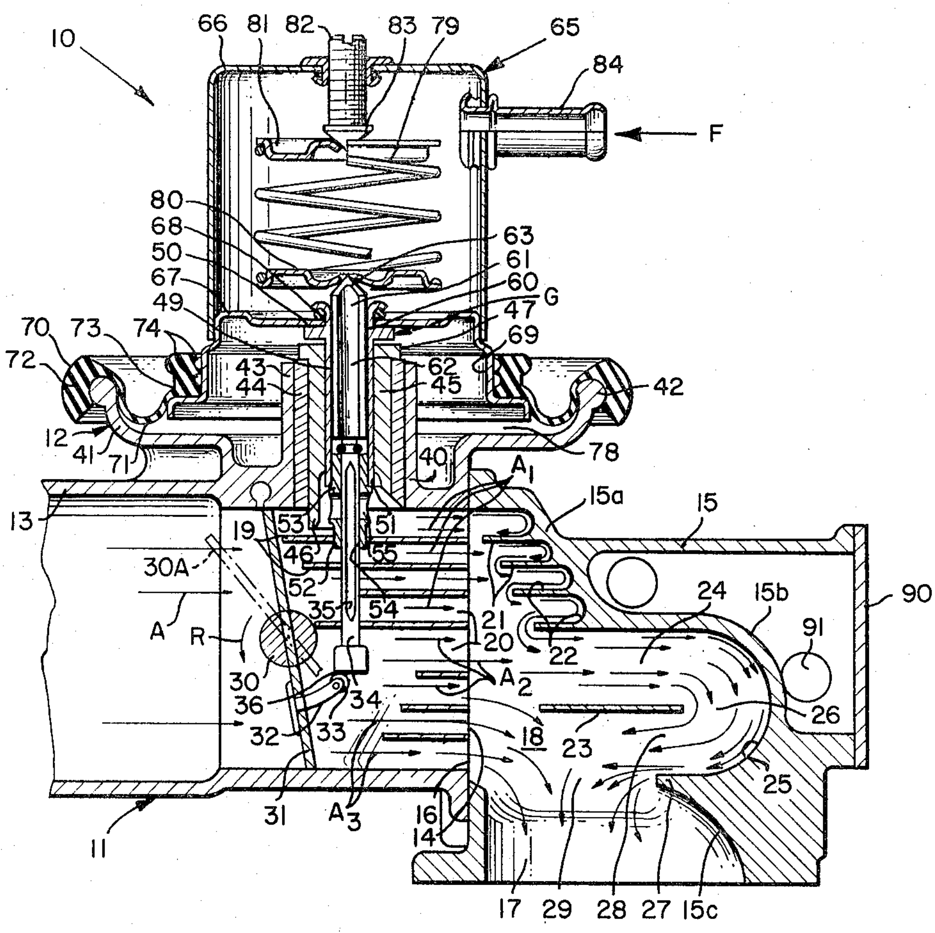

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FIG.1

VEHICLE FUEL INJECTOR AND CARBURETOR UNIT

This is a continuation-in-part utility patent application relative to copending U.S. application Ser. No. 216,361 filed Jan. 10, 1972, by Oscar R. Cedarholm for a "Vehicle Fuel Injector," now U.S. Pat. No. 3,814,391.

BACKGROUND OF THE INVENTION

This invention generally relates to carburetors and more specifically relates to vehicle carburetors capable of thoroughly atomizing fuel in order to reduce smog and air pollutants.

This invention is an improvement over the one described in the above-mentioned application and also relative to the carburetor atomization structure disclosed in U.S. Pat. No. 3,559,963 to Cedarholm in which fuel droplets temporarily trapped in corrugations formed in a mixing chamber wall are blasted by entering air streams in order to assist in atomizing the fuel.

Other Cedarholm patents related to this invention are: U.S. Pat. No. 2,653,804; U.S. Pat. No. 2,762,615 and U.S. Pat. No. 2,984,467.

SUMMARY OF THE INVENTION

Briefly stated, this present invention is a fuel injection and carburetor unit which coact to appreciably improve atomization of fuel in order to increase combustion efficiency.

In its broader aspects this invention includes an atomization housing having a back wall and which defines a mixing chamber for accepting and mixing charges of air and fuel. Air inlet structure defines an air inlet oriented in communication with the mixing chamber so that the mixing chamber and air inlet define a generally continuous flow passageway. A throttle valve is positioned in the continuous flow passageway in order to regulate the flow of air into the mixing chamber. A fuel injector is coupled to the atomization housing and a metering valve is connected to the fuel injector and projects into the continuous flow passageway.

The principal aspects of this invention relate to the following features. A plurality of vertically spaced guide plates are coupled to the housing and extend horizontally across the continuous flow passageway. These guide plates are arranged adjacent the metering valve and serve to split in-rushing air into separate streams of air, some of which carry the fuel dispensed by the metering valve deeper into the mixing chamber.

Arranged downstream from the guide plates are a plurality of spaced fins that are coupled to an upper section of the housing back wall. The fins are arranged to define a plurality of pockets which project inwardly and are spaced by gaps from the downstream tips of the guide plates.

A divider is coupled to the housing. An elongated U-shaped channel is defined in part by the divider and in part by a middle section of the housing back wall.

A contraflow collision zone is located generally beneath the divider and in essence is a space where at least a stream of air issuing from between the guide plates violently encounters the air-fuel flow issuing in an opposing direction from the U-shaped channel. A flow outlet opening defined by the housing then carries the thoroughly atomized air-fuel mixture into a vehicle manifold.

The fins are preferably aligned with corresponding guide plates so that the fuel deposits that are temporarily trapped in the pockets can be directly blasted by the streams of air issuing from between the guide plates. The fins terminate in inwardly projecting tips that are spaced, from top to bottom, by ever-widening gaps from the downstream ends of the guide plates. Turbulence is caused within these gaps between the air-fuel flow being forced out of the pockets and streams of air issuing from between the guide plates.

The U-shaped channel has an upper conduit segment in direct communication with the lowermost pocket for routing the air-fuel flow generally rearwardly. A bend conduit segment accepts the air-fuel flow from the upper conduit segment and reverses its direction. A lower conduit segment then routes the air-fuel flow forwardly and straight into the streams of air issuing from between lowermost guide plates.

The U-shaped channel is larger and extends more rearwardly than the pockets.

The divider is a horizontally extending plate and its major portion is disposed within the U-shaped channel. Preferably the divider is positioned centrally within the U-shaped channel.

BRIEF DESCRIPTION OF THE DRAWING

The numerous benefits and unique aspects of the present invention will be fully understood when the following detailed description is studied in conjunction with the drawing in which:

FIG. 1 is a side elevational, longitudinally sectional view of a vehicle fuel injector and carburetor unit, constructed in accordance with this invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The drawing shows a vehicle fuel injector and carburetor unit **10** constructed to finally atomize fuel charges prior to combustion in order to significantly minimize smog problems.

Unit **10** includes a fuel injector and atomizer housing **11**. Housing **11** has a major or central part **12** which includes an air inlet duct or structure **13** that may be separable or integral. The air inlet structure **13** defines an ambient air inlet passage **14**.

A side part **15** or fitting of housing **11** defines a generally downstream end or back wall that includes an upper section **15***a* which widens or diverges downwardly, a middle section **15***b* which is generally an elongated socket and a lower section **15***c*. The side part **15** has a large flow inlet opening **16** in communication with flow passage **14** and a flow outlet opening **17** that leads to a vehicle manifold (not shown).

A generally continuous flow passageway is defined by the air inlet duct **13** and housing **11** which includes the air passageway **14** and mixing chamber **18** generally contained by the housing side part **15**.

The ambient or external air A drawn through the air inlet duct **13** is forced into a series of vertically spaced guide plates **19** that extend horizontally across the air passage **14** and are secured by their side edges to housing major part **12**. The guide plates **19** are arranged to split the incoming ambient air A into separate streams of air, relatively upper streams of air A_1, relatively middle or central streams of air A_2 and relatively lower streams of air A_3. The relatively upper guide plates are longer than the relatively lower guide plates and the guide plates **19** are generally evenly spaced to form the spaces **20** through which the individual streams of air A_1, A_2 and A_3 flow and egress.

Across a variable distance gap from the downstream tips of the relatively upper guide plates **19** are a series of vertically spaced fins **21** formed by the housing back wall upper section **15***a*. The fins **21** define a series of horizontally extending pockets **22**.

The fins **21** are aligned with corresponding upper guide plates **19** so that the pockets **22** will be aligned with the upper streams of air A_1 issuing from between the upper guide plates **19**. Fins **21** terminate in the mixing chamber **18** with inwardly projecting tips that are spaced from corresponding guide plates **19**. In a direction from top to bottom, the gaps between the guide plates **19** and fins **21** increase.

The middle section **15***b* of the housing back wall is shaped to coact with a divider **23** in describing a U-shaped channel **24**. Divider **23** is a horizontally extending plate and the major portion of it is disposed centrally within the u-shaped channel **24**. Divider **23** serves as a baffle and a guide as shall be subsequently explained.

The U-shaped channel **24** has an upper conduit segment arranged in direct communication with the lowermost pocket **22** and also with the intermediate streams of air A_2 issuing from between the guide plates **19**. A bend conduit segment **25** serves to reverse the direction of fluid passing through the U-shaped channel **24** as the fluid is routed through back passage **26**. The flow is ultimately driven in an upstream or forward direction by a lower conduit segment **28** of the U-shaped channel **24**. The U-shaped channel **24** is an elongated socket with generally cylindrical side walls and a rounded rear wall.

A ledge or ridge **27** assists in diverting flow from the lower conduit segment **28** into a contraflow collision zone **29** beneath the divider. The purpose of this shall be subsequently more fully explained. The flow ultimately departs housing **11** through opening **17** to a manifold.

For purposes of illustrating a fuel injection system capable of working with the carburetor components described above, that particular injection system disclosed in the previously-mentioned, pending U.S. patent application will now be described.

Journalled within a bearing in housing **11** is a rotatable control shaft **30** suitably connected through a conventional linkage to a vehicle accelerator pedal (not shown). Depression of the accelerator pedal by the driver causes shaft **30** to rotate in a direction indicated by the directional arrow R, which in turn causes a butterfly-type throttle valve **31** to rotate from a closed position, indicated by the solid lines to a progressively more opened position indicated by the dot-dash line **30**A. As the throttle valve **31** becomes increasingly opened then greater charges of air A are admitted into the spaces **20** defined by the guide plates **19**. A part of the throttle valve **31** below the axis of shaft **30** mounts a linking arm **32** terminating in a cam **33**.

A generally vertically aligned elongated needle-type metering valve **34** depends into the ambient air passage **14** and is positioned adjacent a number of the upper and intermediate guide plates **19**. Metering valve **34** is formed in its periphery with a longitudinally extending fuel injection channel **35** which is gradually enlarged from its upper end and over a suitable distance to obtain desired variable flow characteristics. The base **36** of metering valve **34** operates as a cam follower and is constantly engaged by cam **33**. As shaft **30** is rotated in direction R, cam **33** lifts metering valve **34** exposing an increasingly greater zone of the fuel injection channel **35** so that the incoming charges of air and fuel may be synchronized in a pre-determined ratio.

An upper atomization section of the housing **11** has an upwardly extending annular neck **40** formed with a radially outwardly extending dish-shaped flange **41**. The flange **41** terminates in a circular-shaped beaded portion or lip **42**. An inner section of neck **40** includes an upstanding annular wall **43** fixed to an internal tubular bushing **44**.

Positioned internally of bushing **44** is a stationary intermediate tube **45** that defines a bore and has a depending lower section defining a deflector plate **46**. The deflector plate **46** or shield surrounds the metering valve, preferably the valve seat, in order to protect it from the incoming air stream. Without this deflector plate **46** the incoming air stream would force minute quantities of fuel into the vacuum chamber **78** where fuel would accumulate in an undesired quantity. With the deflector plate **46** in place the air stream flows past the metering valve on both sides creating an eddy in back of the metering valve so that the circulating air may draw fuel in the downstream direction. The upper end of intermediate tube **45** constitutes a bearing seat.

Situated within the bore of intermediate tube **45** is an axially movable shuttle **49** whose upper end **50** is located adjacent bearing seat **47** which constitutes a stop flange. The shuttle lower end **51** is internally threaded. Positioned generally within the upper zone of the mixing chamber **18** is a valve seat **52** that has an externally threaded upper section **53** which is threadably interengaged with shuttle lower end **51** so that the two components can be moved upwardly or downwardly together. Valve seat **52** has a central bore **54** which serves as a guide way for metering valve **34**, and, has a series of flow passages **55** through which fuel from channel **35** may be dispensed into the in-rushing streams of air A.

Under normal dead engine conditions, the stop flange **50** and bearing seat **47** are separated by a slight gap G. During idling and deceleration conditions no gap G is present. During steady throttle and cruising conditions the gap G will be larger than during dead engine conditions.

The bore of shuttle **49** contains a plunger rod **60** of solid cross section which has a plurality of flow channels defined in part by radially outwardly projecting ribs **62**. The upper end of plunger rod **60** terminates in an apex or cone tip **63** and the lower end **64** of plunger rod **60** contacts the metering valve **34**.

The fuel injector includes a fuel container **65** with a cylindrically-shaped top plate **66** and a disc-shaped bottom plate **67** welded or otherwise secured in fluid-tight relationship with the plate **66**. The uppermost tip **68** of shuttle **49** is inserted through a central opening of plate **67** so that stop flange **50** and tip **68** can tightly engage, either directly or indirectly, opposing faces of plate **67**. Plate **67** has an outer depending skirt **69** that is generally surrounded by a diaphragm **70**.

Diaphragm **70** includes an intermediate thin flexible pressure sensitive strip **71** joined to an end band **72** and an inner end band **73**. Outer band **72** is generally thick and durable and shaped for making leakproof, snap-fitting engagement on the periphery of the lip **42** of annular neck 40. The inner band is also generally thick and durable and has a series of gripping ribs or seals 74 that are sized to make tight, leakproof engagement against the depending skirt 69. The generally confined space defined in part by the annular neck 40, diaphragm 70 and plate 67 constitutes a vacuum chamber 78. When the pressure within the vacuum chamber 78 is decreased due to acceleration, the fuel container 65 moves upwardly under force from a coiled compressed spring 79 and causes the diaphragm 70 to flex. Shuttle 49 is therefore automatically caused to move upwardly to block off partially supply of fuel to the mixing chamber. The effect of this action is to reduce fuel flow and thus maintain the correct amount of fuel relative to the throttle opening.

Confined within the fuel container 65 is the spring 79 that mounts the lower retaining disc 80 in contact with the cone tip 63 of plunger rod 60, and, mounts an upper retaining disc 81 arranged in contact with a downwardly extending cone tip 83. Cone tip 83 is part of an adjustment screw 82 threadably engaged within a fitting mounted within fuel container 65. The coil spring 79 immersed in the fuel F floats between the two cone tips while being supported between the two retaining discs. A nipple 84 admits fuel into the fuel chamber defined by container 65.

Housing side part 15 includes a water jacket 90 with flow conduits 91 through which hot fluid may flow in order to improve the heating efficiency and carburetion in general.

Conventional mechanisms and controls, not within the scope of this invention, may be employed to operate the fuel injection and metering components and for synchronizing the actions of throttle valve and metering components.

OPERATION

Keeping the above construction in mind, it can be understood how some of the disadvantages of carburetor systems are overcome by this invention.

Upon starting a motor vehicle engine incorporating the vehicle fuel injector 10, atmospheric pressure in the intake manifold (not shown) causes a vacuum which draws the ambient air A into the housing 11 and in particular air inlet duct 13. The inrushing ambient air A is guided through the passages 20 defined by the plurality of guide plates 19 that extend horizontally across housing portion 12. An upper segment of ambient air A is split into air streams A_1 that flow past metering valve 34 and pick up metered fuel that has been released from the fuel injection channel 35.

Due to the inertial flow of the continuous fuel and air mixture, this mass passes over the gap between the downstream tips of guide plates 19 and inwardly projecting tips of the fins 21 and these air streams A_1 entrained with fuel are thrust into the pockets 22 of the mixing chamber 18.

The trapped mixture of air and fuel within the pockets 22 is forced to escape against the continuous pressure of inrushing air streams A_1 through the succession of gaps and next lower pockets. During this tortuous path of movement of the air and fuel become subjected to air blasts and increasingly mixed and atomized. The procedure or cycle is repeated in each gap that the air and fuel mixture must pass through.

After departing the lowermost pocket 22 this air fuel mixture is further blasted and comingled with intermediate air streams A_2 and directed into the U-shaped channel 24. The U-shaped channel 24 guides the air-fuel mixture around a 180° turn and redirects its path of movement to head in an upstream direction beneath the divider 23. The divider 23 serves as a baffle and also as a guide. After the mixture of air and fuel has been turned by the U-shaped channel 24 then it is caused to flow in the opposite direction and is driven into the incoming ambient air segment divided into lowermost air streams A_3. This results in a violent collision within the contraflow collision zone 29 between all of the metered air and all of the metered fuel which are subjected to a final mixing. The opposing forces have approximately the same velocity upon impact.

As a result of the inertial flow and pressure of the mixture passing through the multiple pockets, passages and turns the fuel becomes thoroughly mixed and ideally atomized. Close contact with heated fins that are coupled in heat exchange relationship with the water jacket conduits 91 — vaporization is further promoted.

From the foregoing it will be evident that the present invention provides a vehicle fuel injector and operation unit in which all of the various advantages are fully realized.

What is claimed is:

1. A vehicle fuel injector and carburetor unit for atomizing fuel, comprising:

a. an atomization housing having a back wall and defining a mixing chamber for accepting and mixing charges of air and fuel;

b. an air inlet structure having an air inlet in communication with the mixing chamber, the mixing chamber and air inlet defining a generally continuous flow passageway;

c. a throttle valve positioned in the continuous flow passageway to regulate the flow of air into the mixing chamber;

d. a fuel injector coupled to the atomization housing;

e. a metering valve connected to the fuel injector and projecting into the continuous flow passageway;

f. vertically spaced guide plates coupled to the housing and extending horizontally across the continuous flow passageway, the guide plates being arranged adjacent the metering valve to split incoming air into separate streams of air;

g. spaced fins coupled to an upper section of the housing back wall at a location downstream of the guide plates, the fins being arranged to define plural pockets that project inwardly towards the guide plates — wherein, the fins serve to break up and atomize the fuel while the pockets temporarily hold fuel for being successively blasted and further atomized by the streams of air issuing from between the guide plates;

h. a divider coupled to the housing;

i. a U-shaped channel defined by the divider and a middle section of the housing back wall;

j. means defining a contraflow collision zone generally beneath the divider where at least a stream of air from between the guide plates encounters the air-fuel flow issuing generally in the opposite direction from the U-shaped channel; and,

k. a flow outlet opening defined by the housing and located downstream of the contraflow collision zone,

wherein, the combined effects and coaction of the guide plates, the fins and pockets, divider, and U-shaped channel aid in atomizing fuel to improve combustion.

2. The structure according to claim 1 wherein:
the fins are aligned with corresponding guide plates so that fuel temporarily trapped in the pockets can be directly blasted by the streams of air issuing from between the guide plates.

3. The structure according to claim 2 wherein:
the fins terminate in inwardly projecting tips which are spaced, from top to bottom, by ever-widening gaps from the downstream ends of the guide plates, and, turbulence is caused in these gaps between the air-fuel flows being forced out of their pockets and the streams of air issuing from between the guide plates.

4. The structure according to claim 1 wherein the U-shaped channel includes:
a. an upper conduit segment in communication with the lowermost pocket for routing the air-fuel flow rearwardly;
b. a bend conduit for reversing the direction of the air-fuel flow; and,
c. a lower conduit segment for routing the air-fuel flow forwardly into the streams of air issuing from between the lowermost guide plates.

5. The structure according to claim 4 wherein:
the U-shaped channel is larger and extends more rearwardly than the pockets.

6. The structure according to claim 1 wherein:
the divider is a horizontally extending plate, the major portion of which is disposed within the U-shaped channel.

7. The structure according to claim 6 wherein:
the divider is positioned centrally within the U-shaped channel.

8. The structure according to claim 1 wherein:
a. the fins are aligned with corresponding guide plates so that the fuel temporarily trapped in the pockets can be directly blasted by the streams of air issuing from between the guide plates;
b. the U-shaped channel includes an upper conduit segment in communication with the lowermost pocket for routing the air-fuel flow rearwardly, a bend conduit segment for reversing the direction of the air-fuel flow, and, a lower conduit segment for routing the air-fuel flow forwardly into the streams of air issuing from between the lowermost guide plates; and,
c. the divider is a horizontally extending plate, the major portion of which is disposed within the U-shaped channel.

9. The structure according to claim 8 wherein:
a. the U-shaped channel is larger and extends more rearwardly than the pockets; and,
b. the divider is positioned centrally within the U-shaped channel. U-shaped channel.

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