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Donaldson

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[54] **IMPACT ATTENUATING, REPLACEABLE POWERPLANT SUPPORT**

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[51] **Int. Cl.** **B60r 21/00**

[58] **Field of Search** ..... 180/64 M, 64 L, 82 R; 85/9 R; 296/28 G; 293/85, 86, 89; 267/139, 162

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[57] **ABSTRACT**

An easily replaceable powerplant support is disclosed for use on motor vehicles, of either rigid frame or unit body construction. The two main intercostal members are adaptable to engage impact attenuating devices while the vehicle is in use; as well as being adaptable to engage a powerplant removal fixture during removal or replacement of the powerplant and its support for maintenance and inspection or substitution.

4 Claims, 4 Drawing Figures

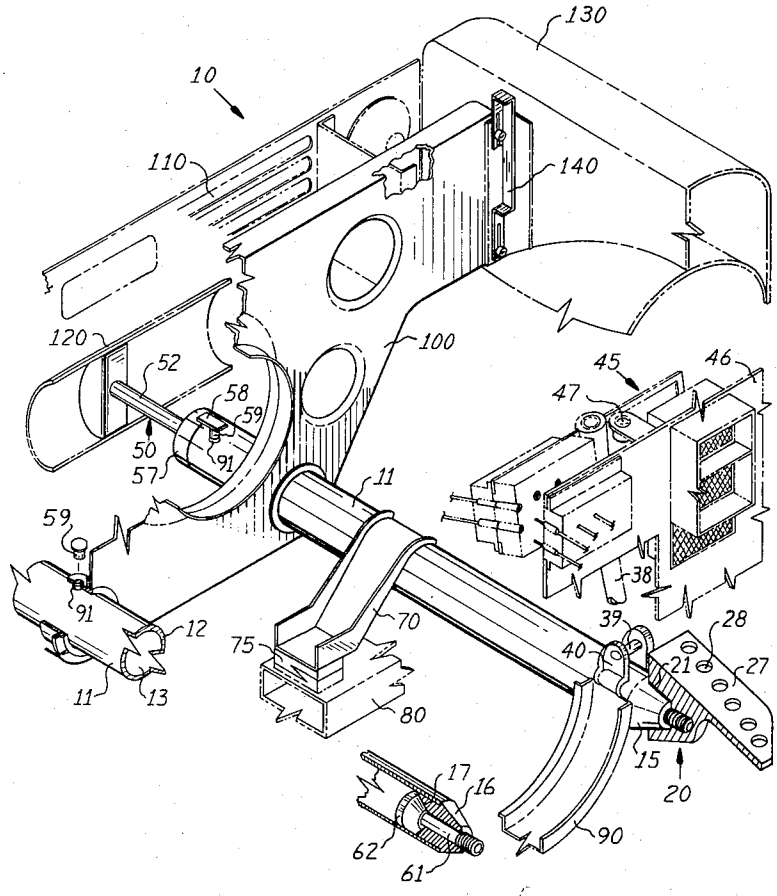
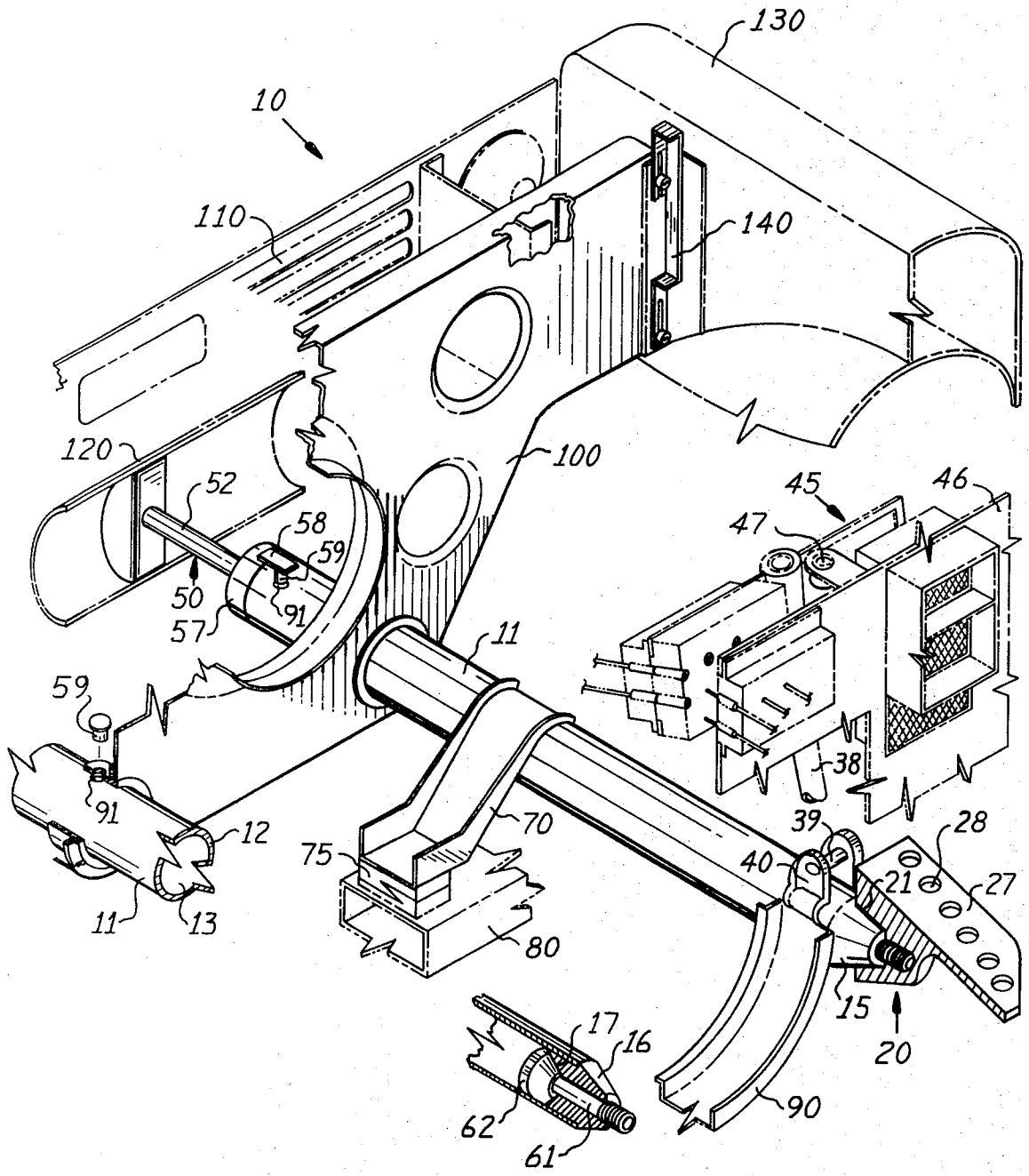


FIG. 1.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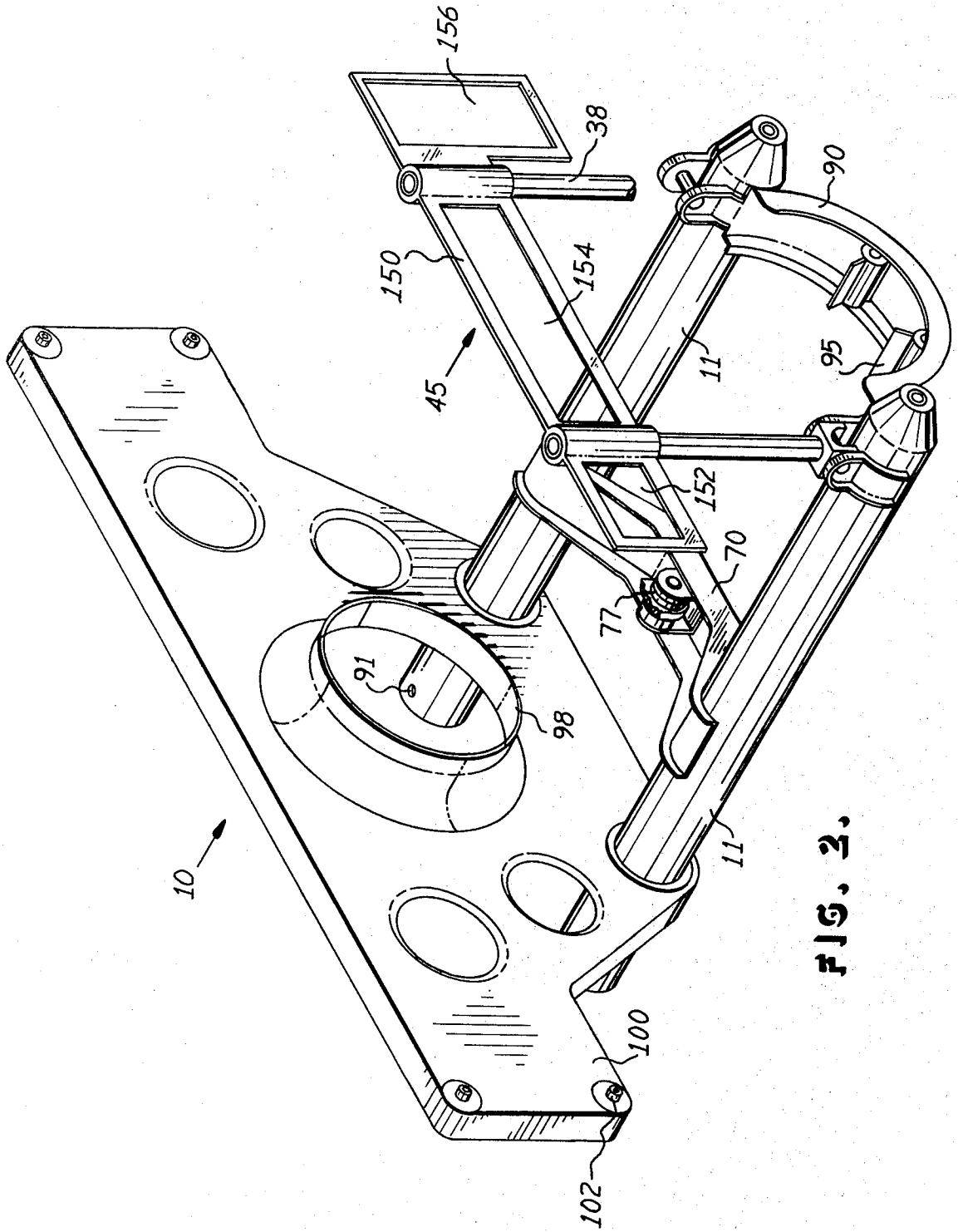

FIG. 2.

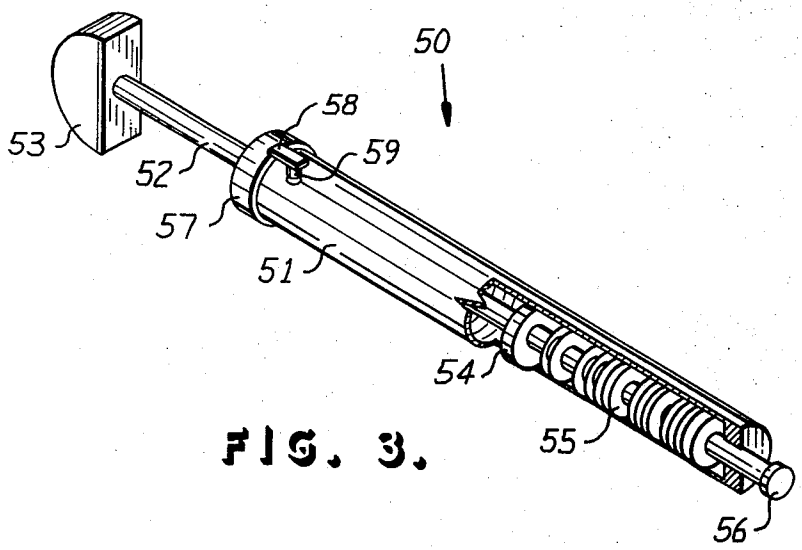

FIG. 3.

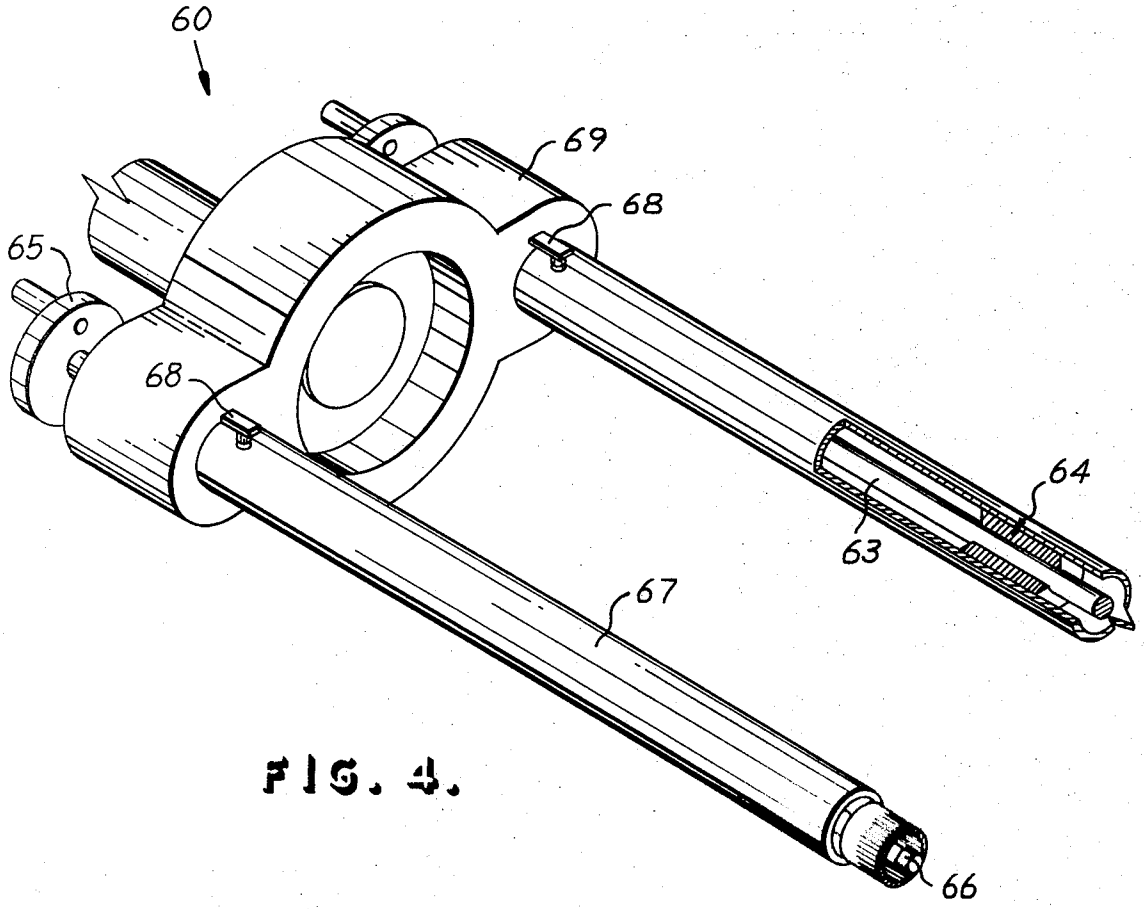

FIG. 4.

IMPACT ATTENUATING, REPLACEABLE POWERPLANT SUPPORT

BACKGROUND OF THE INVENTION

Despite the tremendous strides that have been made by the automotive industry since the introduction of the horseless carriage, two areas of vital significance have been neglected by the manufacturers to the detriment of the general public: Namely, control of pollution emitting from exhausts and the safety of the occupants of the vehicle.

With the ecology-minded population now being more concerned than ever with the preservation of the natural environment, much and varied legislation has been introduced by numerous governmental bodies and agencies at all levels, in an attempt to control the amount and type of pollutants emitting from motor vehicle exhausts. This has resulted in the adoption of greatly varying, sometimes inconsistent regulations about the size and type of powerplants that may be used in different areas of the country. It is quite obvious that some geographical areas, for example, the Los Angeles basin, are more beset by smog problems than are the rural areas. Consequently, it is apparent that more rigid controls would have to be enacted in most of the urban areas than would correspondingly be required in rural areas. This has left the automotive manufacturers with almost an insurmountable dilemma, since an engine currently manufactured may be acceptable in some parts of the country but not acceptable in others. Heretofore a change in the size and type of the engine itself has unnecessarily resulted in a change in the entire design of the vehicle.

A primary purpose of this invention is to provide a readily replaceable powerplant support of a minimal number of standardized sizes and dimensions so that the automotive manufacturers could quite easily produce motor vehicles of standardized appearance; and yet have a variety of engines or powerplants that could be readily installable in the same vehicle to comply with local pollution control requirements. Consequently, vehicles of identical appearance might be used in Los Angeles or Death Valley, which differ only in the size, type or model of the engine installed in each said vehicle.

It may also be seen that using the proposed invention, should a particular engine fail to comply with pollution control requirements, the engine could be readily removed and another inserted without the owner having to purchase an entire new vehicle.

Naturally, during the life of any motor vehicle, the engine must be worked on from time to time for numerous reasons, thus necessitating the entire vehicle to be tied up in a shop for a day or more, and thereby depriving the owner of the use of said vehicle all during that time. He must either change his schedule or rent another vehicle at his own expense. Thus, there is an urgent need to have a replaceable powerplant support so that in case extended maintenance is required, the owner can simply bring his vehicle in, have the original powerplant and support removed for maintenance or inspection and have a substitute powerplant and support installed; and soon be on his way in a matter of minutes. After the maintenance has been completed, the owner can then return and have the powerplant supports and engines switched. Once the engine has been removed on its replaceable support using this novel method, it can easily be temporarily connected to a removal fixture so that all of the engine is accessible from all sides and more easy to work on than it would be if it were still enclosed in the vehicle.

Last, but not least, is an area of most vital concern to the general public, namely the safety of the occupants during the operation of the vehicle. Many governmental agencies have enacted, or are in the process of enacting, legislation to set up minimal requirements for vehicles to be able to withstand minor collisions at low speeds without damage to the safety equipment. Impact attenuators have been known in the prior art to reduce the potential danger to the occupants; however, their effective use has been quite limited due to the tremendous variance in automotive design construction. The two basic types of automotive body designs are the rigid frame construction and the unit body construction.

The rigid frame construction is much easier to assemble by the manufacturer, and is more protective to the vehicle itself in the event of a collision; however, the rigid frame does not have the cushioning effect that the unit body does in the event of a major impact, necessarily resulting in the abrupt transmittal of force to the passenger compartment, thereby making the passenger more susceptible to injuries such as whiplashes.

One of the novelties of the present invention is that it combines the advantage of a rigid frame with regard to minor impacts, and the advantage of a unit body with regard to major impacts. This is because it preserves the rigidity of the frame up to a point of failure, above which the engine compartment cowling can collapse, thereby absorbing the impact as would a unit body construction.

As will be seen from the following description, this novel and unique replaceable powerplant support accomplishes all of the objectives set forth above as well as many others.

SUMMARY OF THE INVENTION

The invention comprises a replaceable powerplant support, generally designated by reference numeral **10,** having two tubular main intercostals **11,** each said intercostal having an elongate void or passageway therein and adapted to contain a conventional impact attenuator while the vehicle is in operation, or adapted to contain a powerplant removal fixture during removal or replacement of the powerplant. The intercostal member **11** has an intercostal fitting **15** at the end opposite the impact attenuator **50** to aid self-alignment of the intercostal fitting **15** into the vehicle support fitting **20.** The vehicle support fitting may be adapted to any type of vehicle. The firewall interface support **38** is hinged at the base for easy disengagement from the firewall prior to the powerplant removal. The main cross-member **70** serves to rigidly affix the support framework to the vehicle suspension cross-member **80,** as well as providing a base for powerplant shock or torsional restraint mounts, one being shown by numeral **77.** The forward bulkhead **100** serves as the vehicle bulkhead as well as the supporting structure for the cooling system, battery, logical subsystems and uniformly designed fan cowling, etc. By sliding the forward bulkhead **100** toward the open end of the main intercostal **11,** the powerplant fanblades (not shown) would disengage the fan

cowling **98.** The transmission support member **90** provides a base for the transmission shock or torsional restraint mounts **95,** as shown in FIG. **2.**

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a view, partly in cross-section, showing the novel replaceable powerplant support with the impact attenuator as it would appear installed in the vehicle.

FIG. **2** is a view of the replaceable powerplant support without the impact attenuators.

FIG. **3** is a more detailed view of the impact attenuator.

FIG. **4** is a detailed view of the powerplant removal fixture.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings in this case, and particularly to FIG. **1,** it may be seen that the invention contemplates and includes a replaceable powerplant support generally designated by reference numeral **10.** Powerplant support **10** may be any of various standardized sizes that are adapted for use on conventional motor vehicles including cars, trucks, and vans.

Although the main intercostals may have a wide variety of different cross-sectional forms or shapes, the preferred embodiment is seen in FIG. **1** wherein each main intercostal member has a substantially tubular cylindrical appearance. Moreover, it may be seen from FIG. **1** that an elongate hollow void or passage **13** within intercostal member **11** is substantially cylindrical in shape contigous with the circular inner portion **12.**

The impact attenuator generally designated by reference numeral **50** comprises a cylindrical structure **51** in which is mounted a plunger **52** secured at one end to an impact transmitting element **53.**

As seen in FIG. **1,** the external bumper of the vehicle **120,** which may be of any size or shape, and which may or may not be contiguous is adapted to fit snugly over the impact transmitting element **53,** but may or may not be permanently secured to said element.

In the event of a minor collision of an object with bumper **120,** the longitudinal force resulting from said collision is transmitted to the plunger **52** by means of the impact transmitting element **53.** Said force then causes longitudinal movement of the plunger **52** within cylinder **51,** so that plunger **52** in turn causes compression of a plurality of spring washers, generally and collectively designated by reference numeral **55,** by means of piston **54,** which is rigidly attached to plunger **52** so longitudinal movement of the plunger **52** causes corresponding movement of the piston **54.** Movement of piston **54** causing deformation of spring washers **55.**

As seen in the preferred embodiment, the spring washeres may be Belleville type which are substantially conical in profile in an unloaded or not fully loaded condition, which absorb the transmitted collision force due to the physical property of the washers, which become flattened under maximum loading. In the preferred embodiment the washers **55** are arranged in a sequentially increased plurality of opposed parallel groups.

It is understood, of course, that the impact attenuator may also be hydraulic, or pneumatic or a combination of the two, or a conventional helically wound spring, or any other conventional means for absorbtion of the collision forces. In the minor collision, the attenuator would essentially return to its original condition.

In the event of a major collision, the plunger cap **56,** which is rigidly secured to the plunger **52** at its end opposite impact transmitting element **53,** concurrently with the full deformation of spring washers **55** would bear upon the head **62** of the internal wrenching bolt **61,** as shown in FIG. **1.** This force is transmitted longitudinally through the head **62** which bears upon the main intercostal member fitting **15,** which in turn, bears upon the vehicle support fitting **20.** The collision is thereby transmitted from element **53** to the vehicle by way of shear fasteners (not shown) which couple vehicle support fitting **20** to the passenger compartment underframe (not shown).

Thus in the event of a major collision, in excess of the capacity of the shear fasteners (not shown) the vehicle support fitting **20** may move longitudinally and downward away from the vehicle passenger compartment underframe, thereby permitting the vehicle's forward structure including the fenders **130** and forward bulkhead **100** and suspension cross-member **80** as well as the shear failure of the interlocking shoe assembly **75** intermediate the main cross-member **70** and vehicle suspension cross-member **80** thereby absorbing additional impact forces, as would occur in a conventional unit body type construction vehicle.

It will be seen from FIG. **1** that the vehicle support fitting **20** has an upper surface **27,** of which the end proximate the intercostal member **11** would be at a greater height above the ground than the opposite end of said surface **27.** The angle of slope of said surface **27** should be at least great enough to result in downward movement as well as longitudinal movement of the support fitting **20** in the event of a major collision, in excess of the capacity of the impact attenuators **50.**

It may also be seen that the upper surface **27** has a series of apertures, collectively referred to as **28,** to provide a bearing surface for application of force to said shear fasteners (not shown). The shear fasteners may be cylindrical and include bolts or rivets which penetrate the apertures **28,** at one end and are connected to vehicle interface fitting (not shown) at the other end of the shear fasteners.

Concurrent with the failure of said shear fasteners, and longitudinal and downward displacement of the vehicle support fitting **20,** the vehicle firewall interface upright, elongate support column **38** separates from the brackets **40** due to failure of the hinge pin **39** mounted intermediate the ends of said bracket **40,** permitting the firewall support assembly generally designated by reference numeral **45** to remain engaged to the vehicle firewall **46.** This is due to the holding capacity of the locking device **47.**

In the event of a major collision, assuming that the total mass centroid is at a greater distance from the ground than at the primary point of impact, the vehicle would tend to rise above and about the point of impact, thereby increasing the gap between the vehicle underbody and the road surface. The longitudinal and downward thrust of the powerplant support framework would in turn transmit a corresponding force to the engine through the engine shock mount or torsional restraint mounts **95** mounted on transmission support cross-member **90** and shock mounts **77** on the main cross-member **70.** This occurs concurrently with collapse of the vehicle forward structure. Consequently, it

is apparent that the novel invention reduces the possibility of the engine being displaced into the passenger compartment as a result of a major impact.

The impact attenuator outer cylinder **51** is supported within the void or passage **13** of the intercostal member **11** by being juxtaposed to the inner surface **12** of the intercostal member **11** and is retained within the intercostal member **11** by bearing upon the flange or shoulder **57** and being retained by a biasing means such as a clip **58** shown in FIGS. **3** and **1.** A pin **59** is affixed to clip **58,** and said pin is adapted to engage the aperture **91** on the intercostal **11.**

At the end of the intercostal member **11,** proximate the firewall, generally designated by reference numeral **46** is tapered main intercostal fitting **15** which may be either swaged or welded to the main intercostal **11.** Main intercostal fitting **15** is tapered, internally and externally. The externally tapered wall **16** of said main intercostal fitting **15** aids self-alignment of the fitting, generally designated by reference numeral **15** into the vehicle support fitting **20.** The internally tapered wall **17** of the main intercostal fitting **15** aids in the seating and self-alignment of the internal wrenching bolt **61.**

The internal hollow passage **13** of the intercostal member **11** is adapted to contain the impact attenuator **50** while the vehicle is in use or the removal fixture generally designated by reference numeral **60** during the powerplant removal, overhaul, replacement or inspection.

The vehicle support fitting **20** may be made of metal casting or forging, with a tapered receptacle **21** adapted to engage the main intercostal fitting **15.**

The tapered receptacle **21** of said vehicle support fitting **20** terminates in a tapped hole adapted in size and shape to contain the internal wrenching bolt **61.**

The main cross-member **70** serves to rigidly affix the support framework to the vehicle suspension cross-member **80** as well as providing a base for the powerplant shock or torsional restraint mounts **77.** It will be seen from FIG. **1** that the upper ends of said main cross-member **70** which are proximate the intercostal members slope downward at a gradually increasing angle in the form of a U-channel and the bottom wall of said U-channel becomes horizontal to the ground near its connection with the powerplant shock mounts **77.**

The forward bulkhead **100** serves as a vehicle bulkhead as well as the supporting structure for the cooling system, electrical subsystems, uniformly designed fan-cowling **98,** vehicle grill **110,** and all other logical systems inherent to the various types of powerplants.

The transmission support member **90** may be U-channelled and semi-circular or semi-eliptical in shape and provides a base for the transmission shock or torsional restraint mounts **95.**

The uppermost portion, generally designated by reference numeral **150,** of the firewall support assembly **45,** is subdivided into a plurality of framed openings. Numeral **152** refers to an opening through which instrumentation and controls characteristic of a predetermined powerplant are placed. Numeral **152** would oppose a correspondingly shaped opening (not shown) within the vehicle firewall for visual and manual access of said instrumentation and controls.

Opening **154** is adapted to engage predetermined electrical interface connections between the vehicle and the powerplant.

Opening **156** is adapted to engage predetermined air circulation systems.

It will be seen that the powerplant support may be readily removable as follows:

First of all, it is not necessary to disconnect a multitude of electrical connectors such as the battery, voltage regulator, starter relay, etc. that would have to be disconnected to remove the powerplant in the conventional method of mounting an engine. This is because the novel invention comprises a forward bulkhead and a firewall interface support assembly that maintain a continual relationship between the engine and its electrical systems.

Secondly, hose connections need not be disconnected because the radiator is also supported by the bulkhead in the proposed system.

Thirdly, the air inlet associated with the powerplant need not be removed.

Fourthly, the shock or torsional restraint mounts need not be disconnected.

Using the novel replaceable powerplant support as described above, the upper lock **47** which restrains the vehicle interface support assembly **45** disengages the said support from the firewall **46.**

The impact attenuators **50** are removed together with bumper **120** by releasing the biasing clips **58** and withdrawing said attenuators from the main intercostals **11.**

Then a removal fixture **60** is inserted into the intercostals **11.**

A conventionally slidable lock **140,** disengages recesses in bulkhead retaining pins, collectively designated by reference numeral **102,** thereby releasing the forward bulkhead **100** from vehicle fender **130.**

Then the bolthead torque applicator **66** of the removal fixture **60,** engages the recess in the head **62** of the internal wrenching bolt **61.** Said torque applicator is rigidly affixed to shaft **63** which is free to rotate within bushing **64** and slide longitudinally relative to said bushing. The shaft **63** is ridigly affixed to crank **65** for the purpose of transmitting torque to torque applicator **66** to remove the internal wrenching bolt **61.**

After all the bolts **61** have been loosened or disengaged from the tapped hole in support fitting **20,** the powerplant support **10** may be withdrawn from the vehicle.

It is apparent that the cross-sectional area of the internal void or passage **13** of intercostal member **11** is greater than the cross-sectional area of the tubular member **67** of the removal fixture **60.**

The withdrawal of the powerplant support **10** from the vehicle is facilitated by the use of a biasing clip **68** secured to the tubular member support housing **69.**

I claim:

1. A replaceable power plant support comprising:

a plurality of main intercostal members, each said member being substantially tubular in shape and having an elongate void or passage therein,

a plurality of main intercostal fittings, each said main intercostal fitting secured to one end of each said main inercostal member and tapered, internally and externally, to aid selfalignment of each said main intercostal fitting into each vehicle support fitting and to aid in the seating and self-alignment of each internal wrenching bolt,

a plurality of vehicle support fittings, each said vehicle support fitting having a tapered receptacle

adapted to engage each said main intercostal fitting, sand the receptacle terminates in a tapped hole adapted in size and shape to contain each internal wrenching bolt, and each said vehicle support fitting's upper surface of which the end, proximate each said main intercostal member, would be at a greater height above the ground than the opposite end of said surface, and said surface has a series of apertures,

a main cross-member, perpendicular to each said main intercostal member, which secures each said main intercostal member in a parallel relationship to one another,

a plurality of internal wrenching bolts, each bolt adapted to be contained within each said support fitting,

shear fasteners which penetrate the apertures on the surface of each said vehicle support fitting at one end of said fasteners and are connected to a vehicle interface fitting at the other end of said shear fasteners,

a plurality of brackets, each of which is mounted on each said main intercostal member proximate each said main intercostal fitting,

a plurality of hinge pins, each of which is mounted intermediate the ends of each said bracket, and

a plurality of vehicle firewall interface upright, elongate support columns, each said column having each said hinge pin inserted through each said column, whereby each said support column will separate from each said bracket upon failure of each said hinge pin.

2. A replaceable power plant support comprising:

a plurality of main intercostal members, each said member being substantially tubular in shape and having an elongate void or passage therein,

a plurality of main intercostal fittings, each said main intercostal fitting secured to one end of each said main intercostal member and tapered, internally and externally, to aid self-alignment of each said main intercostal fitting into each vehicle support fitting and to aid in the seating and self-alignment of each internal wrenching bolt,

a plurality of vehicle support fittings, each said vehicle support fitting having a tapered receptacle adapted to engage each said main intercostal fitting, and the receptacle terminates in a tapped hole adapted in size and shape to contain each internal wrenching bolt, and each said vehicle support fitting's upper surface of which the end, proximate each said main intercostal member, would be at a greater height above the ground than the opposite end of said surface, and said surface has a series of apertures,

a main cross-member, perpendicular to each said main intercostal member, which secures each said main intercostal member in a parallel relationship to one another,

a plurality of internal wrenching bolts, each bolt adapted to be contained within each said support fitting,

shear fasteners which penetrate the apertures on the surface of each said vehicle support fitting at one end of said fasteners and are connected to a vehicle interface fitting at the other end of said shear fasteners,

a plurality of brackets, each of which is mounted on each said main intercostal member proximate each said main intercostal fitting,

a plurality of hinge pins, each of which is mounted intermediate the ends of each said bracket,

a plurality of vehicle firewall interface upright, elongate support columns, each said column having each said hinge pin inserted through each said column, whereby each said support column will separate from each said bracket upon failure of each said hinge pin, and

a plurality of torsional restraint mounts, which are mounted on said main cross-member.

3. A replaceable power plant support comprising:

a plurality of main intercostal members, each said member being substantially tubular in shape and having an elongate void or passage therein,

a plurality of main intercostal fittings, each said main intercostal fitting secured to one end of each said main intercostal member and tapered, internally and externally, to aid self-alignment of each said main intercostal fitting into each vehicle support fitting and to aid in the seating and self-alignment of each internal wrenching bolt,

a plurality of vehicle support fittings, each said vehicle support fitting having a tapered receptacle adapted to engage each said main intercostal fitting, and the receptacle terminates in a tapped hole adapted in size and shape to contain each internal wrenching bolt, and each said vehicle support fitting's upper surface of which the end, proximate each said main intercostal member, would be at a greater height above the ground than the opposite end of said surface, and said surface has a series of apertures,

a main cross-member, perpendicular to each said main intercostal member, which secures each said main intercostal member in a parallel relationship to one another,

a plurality of internal wrenching bolts, each bolt adapted to be contained within each said support fitting,

shear fasteners which penetrate the apertures on the surface of each said vehicle support fitting at one end of said fasteners and are connected to a vehicle interface fitting at the other end of said shear fasteners,

a plurality of brackets, each of which is mounted on each said main intercostal member proximate each said main intercostal fitting,

a plurality of hinge pins, each of which is mounted intermediate the ends of ach said bracket,

a plurality of vehicle firewall interface upright, elongate support columns, each said column having each said hinge pin inserted through each said column, whereby each said support column will separate from each said bracket upon failure of each said hinge pin,

a plurality of torsional restraint mounts, which are mounted on said main cross-member, and

a transmission support cross-member mounted intermediate said main intercostal members.

4. A replaceable power plant support comprising:

a plurality of main intercostal members, each said member being substantially tubular in shape and having an elongate void or passage therein,

a plurality of main intercostal fittings, each said main intercostal fitting secured to one end of each said main intercostal member and tapered, internally and externally, to aid self-alignment of each said main intercostal fitting into each vehicle support fitting and to aid in the seating and self-alignment of each internal wrenching bolt,

a plurality of vehicle support fittings, each said vehicle support fitting having a tapered receptacle adapted to engage each said main intercostal fitting, sand the receptacle terminates in a tapped hole adapted in size and shape to contain each internal wrenching bolt, and each said vehicle support fitting's upper surface of which the end, proximate each said main intercostal member, would be at a greater height above the ground than the opposite end of said surface, and said surface has a series of apertures,

a main cross-member, perependicular to each said main intercostal member, which secures each said main intercostal member in a parallel relationship to one another,

a plurality of internal wrenching bolts, each bolt adapted to be contained within each said support fitting,

shear fasteners which penetrate the apertures on the surface of each said vehicle support fitting at one end of said fasteners and are connected to a vehicle interface fitting at the other end of said shear fasteners,

a plurality of brackets, each of which is mounted on each said main intercostal member proximate each said main intercostal fitting,

a plurality of hinge pins, each of which is mounted intermediate the ends of each said bracket,

a plurality of vehicle firewall interface upright, elongate support columns, each said column having each said hinge pin inserted through each said column, whereby each said support column will separate from each said bracket upon failure of each said hinge pin,

a plurality of torsional restraint mounts, which are mounted on said main cross-member,

a transmission support cross-member mounted intermediate said main intercostal members, and

a plurality of transmission shock mounts, which are mounted on said transmission cross-member.

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