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(54) IMPROVEMENTS IN CHASSIS-FRAME STRUCTURES FOR AUTOMOTIVE VEHICLES

(71) We, REGIE NATIONALE DES USINES RENAULT of 8/10, Avenue Emile Zola, Billancourt (Hauts de Seine) in France, and AUTOMOBILES PEUGEOT of 75, Avenue de la Grande Armée, Paris (France), both French Bodies Corporate, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:—

The present invention relates to chassis-frame structures for automotive vehicles.

Chassis-frame structures for motor vehicles, particularly passenger vehicles, must have a good rigidity in order to withstand distortion stress applied to the passengers' compartment in case of crash and absorb vibration generated by the power unit, on the one hand, and also the consequences of ground unevenness on the trains of wheels and the suspension system, on the other hand.

Besides, these chassis-frames must be constructed as simply as possible and have a minimum weight, for obvious reasons of cost and vehicle performances.

Combining these contradictory requirements by using suitable means constitutes the essential object of this invention.

After the uniform design, used for many years, which consisted of a chassis comprising a pair of longitudinal side members assembled by a number of cross members, a rigid but heavy structure if any, automotive vehicles have been constructed according to the chassis-cum-body technique whereby the inherent rigidity of the body is sufficient for imparting the necessary strength to the vehicle.

Pressed-steel floor chassis have also been constructed wherein the function of the ribbed and partly box-sectioned floor sheets constitute the rigid base structure of the vehicle.

However, self-supporting bodies, due to their greater structural elasticity and their inherent vibration frequencies, do not ensure a satisfactory absorption of vibrations produced by the engine and transmitted from the road surface through the suspension system; therefore, such chassis-cum-body constructions constitute a source of vibratory resonance at certain speeds.

Conventional chassis comprising two longitudinal side members are used only in trucks or very large automotive vehicles, due to their substantial weight and cost.

Pressed-steel or floor-type chassis are used chiefly in light cars or small delivery vans exposed only to limited structural stress. In the case of larger vehicles, the necessity of reinforcing the floor platform make this construction non-competitive in comparison with other structures.

It is the essential object of the present invention to provide a frame structure constituting a combination of chassis elements with a conventional self-supporting or chassis-cum-body structure, as a function of the points of action and reaction of the power unit and suspension system of the vehicle.

The invention provides a chassis-frame structure for an automotive vehicle having a front power unit and transmission mechanism assembly and front wheel drive, the front wheels being connected through thrust links to the chassis frame, the chassis-frame structure comprising a compound chassis consisting of an assembly of three main elements, that is, a first or front element constituted by a pair of lower parallel longitudinal members assembled at their front ends, and by a pair of upper longitudinal members each rigidly assembled at two junction nodes with one of said lower longitudinal members to provide a cradle for the power unit, transmission mechanism assembly and the front wheels, each said upper longitudinal members having an upswept curved portion and an outswept forward extension beyond said lower longitudinal members, the front ends of the forward extensions being interconnected by a curved horizontal cross member, said lower longitudinal members each having a rear extension, the second element consisting of an

intermediate chassis member in the form of a steel pressing formed with pressed reinforcing ribs and constituting a floor of a passenger's compartment and comprising pressed wells for the feet of rear seat passengers, and finally a third or rear element consisting of a pair of parallel longitudinal members having a spacing different to that of said front longitudinal members.

Preferably a first of said two junction nodes interconnects the top of the upsweped curved portion of the upper longitudinal member and the front end of the associated lower longitudinal member, and the second of said two junction nodes interconnects the rear end of the upper longitudinal member and a portion of the associated lower longitudinal member which is located at the rear of said cradle.

It is further preferred that the front junction nodes of the upper and lower front longitudinal members are arranged to receive the main bearing points of the power unit and transmission mechanism assembly, and the bearing points of said thrust links, the other junction nodes of the front longitudinal members receiving furthermore secondary bearing points of the power unit and transmission mechanism assembly.

Preferably a bow-shaped cross member interconnects the pair of upper front longitudinal members behind the upsweped curved portions, said cross member having at its ends oblique nearly vertical built-in uprights arranged to receive at their upper ends bearing points of front wheel suspension elements of the vehicle.

By grouping, at very rigid junction nodes located at the front end, the main mounting points for the power unit and the mounting points for the said thrust links, the vibrations produced in opposite directions by the power unit and front wheels of a vehicle employing the chassis are reciprocally damped out at said junction nodes, the chassis elements lying at a neutral position with respect to the transmission of said vibrations, this position being reinforced by providing rubber blocks at said mounting points.

Similarly, the inherent bending elasticity of the oblique built-in uprights bearing the springs and shock-absorbers of the suspension system co-act with this system for damping out the vibrations caused by road unevennesses and transmitted through the front wheels.

Finally, the type of discontinuous construction of the chassis structure (comprising relatively short longitudinal members connected separately to a steel pressing having very varied reliefs) counteracts the generation and propagation of vibration frequencies inherent to this structure.

The power unit and front wheel assembly or grouping necessitates the reinforcement of the

chassis structure by providing a cradle made up of pairs of longitudinal members only in a relatively limited zone. This may make possible the use of shorter and lighter longitudinal members that can be mass-produced on smaller machines and tools.

It is one object of this invention to prevent or reduce the possibility of this lighter structure impairing the rigidity of the passengers' compartment and therefore compromising the passengers' safety, while promoting the shock absorption capacity of the front portion of the vehicle.

Thus, in case of a front crash the curvature of the front longitudinal side members and their horizontal end inclination will automatically fix its buckling point at its junction node with the lower longitudinal member, thus directing the folding effect downwards, so as to dissipate one fraction of the shock energy by effecting a corresponding lifting of the nose portion of the vehicle and possibly causing the latter to "climb" the obstacle.

A stronger shock, after this initial buckling and the crushing of the radiator, will strike directly the power unit and possibly involve the yielding and eventually the shearing of its mountings; in this case, the power unit will strike the bow-shaped cross member in the shoulder of its rear portion. The backward torsion of this cross member will absorb a complementary fraction of the energy produced by the crash.

Under these conditions, it will be seen that due to this very considerably shock absorbing capacity the structure of the vehicle undergoes but a minimum distortion and that the passengers' compartment, to which only moderate crushing forces are applied, since the heaviest masses are concentrated at the front, remains substantially undamaged.

An embodiment of the invention will now be described by way of example, with reference to the accompanying drawing in which:

Figure 1 illustrates diagrammatically in elevational view the structure of an automotive vehicle constructed according to this invention;

Figure 2 illustrates the same structure but seen in plane view from above;

Figure 3 illustrates in front elevational and sectional view the same structure, the section being taken in a vertical plane III—III of Figure 2 containing the main mountings of the power unit;

Figure 4 illustrates the distortion of the front portion of the frame structure after the latter has absorbed a front shock; and

Figure 5 shows the configuration assumed by the frame structure and the engine position in case of a still stronger front shock.

Referring first to Figure 1 showing in dash and dot lines 1 the external contour of the bodywork of the vehicle, the front frame structure comprising a pair of upper longi-

5 longitudinal members 2 and a pair of lower longitudinal members 3 supports the power unit assembly comprising the radiator 4, the engine 5 and the transmission mechanism or gearbox 6, and the front set of wheels including the wheels proper 7, and the transmission, steering and braking mechanisms, not shown, of these wheels. These mechanisms are connected to the chassis through suspension members 8, and thrust links 9.

10 The upper longitudinal side members 2 are interconnected at their front outswept portions 2₁ by a curved horizontal cross member 10 and behind the engine 5 by an arcuate or bow-shaped cross member 11 overlying the transmission mechanism or gearbox 6.

15 Each upper longitudinal side members 2 comprises a convex curved portion 12 corresponding substantially to the zone surrounding the engine 5; the top 13 of the curved portion 12 constitutes the junction node whereat it is connected to the front end of the lower longitudinal member 3. The latter comprises a rear extension 3₁ behind the rear junction node 14, which lies under the floor-forming steel pressing 15 of the passengers' compartment, said extension 3₁ and the rear end of the upper longitudinal member being rigidly connected to said steel pressing 15. The rear ends 3₂ of the lower longitudinal members 3 are welded to the front wall of the wells 16 constituting the floor for the feet of the rear seat passengers.

20 Similarly, the front ends 17₁ of the pair of rear parallel longitudinal members 17 are connected to the rear wall of said wells 16. The front portion 17₂ of these longitudinal members 17 extend under the floor sheet 15 and are welded or otherwise fastened thereto. The spacing of the parallel longitudinal members 17 is different from the spacing of the longitudinal members 3. The sheet 15 has formed therein a great number of pressed ribs 15₁ for stiffening it and preventing the transmission of undesired vibration. The longitudinal rigidity of the floor portion of the passengers' compartment is also reinforced by longitudinal external or marginal side members 15₂ of known construction, for assembling the floor with the upper portion of the vehicle body 1.

25 The fuel tank 18 is fitted between the rear portions of the rear longitudinal members 17; its flat and reinforced top 19 is level with the upper edge of these longitudinal members and constitutes the floor of the boot.

30 The bearing points 20 of the suspension system 21 of the set of rear wheels 22 are supported by the intermediate portion of the rear longitudinal members 17.

35 In Figure 2 the arrangement of the half cross members 23, 24 supporting the anchor points 25 of the thrust links or arms 26 of the rear suspension are clearly shown; these cross members are fastened to the rear edge

of the floor pressing 15; another cross member 30 disposed between the rear longitudinal members 17 has pivotally mounted thereon a link 32 connected to the rear axle; other cross members 31 and 33 complete the framing of tank 18; at the front and rear ends thereof. Sheets 34 also welded to the body work 1 form lateral extensions of the top of tank 18 to constitute the boot floor.

40 The power unit and transmission mechanism assembly 5, 6 is connected to the under-frame structure at the junction nodes 13 by means of the central engine mountings 13₁ and at the other junction nodes 14 which are at the rear of the transmission mechanism, by means of the gearbox rear mountings 14₁, these mountings being provided according to the well known technique with rubber blocks or like resilient means. The thrust links axes pass through the junction nodes 13 and the links bear on the points 13₂ of the under-frame also through the medium of rubber blocks.

45 The front elevational view of the front train of wheel shown in Figure 3 illustrates the arrangement of the upper and lower wish-bone or like suspension links 8₁ of suspension system 8, the transmission shafts 27 provided with universal joints for transmitting the drive to the front wheels, as well as the oblique uprights 28 rigid with the upper front longitudinal members 2 and also with the arcuated cross member 11, these uprights 28 receiving at their upper ends 29 the bearing points of the suspension elements 8.

50 Figure 4 shows the front portion of the vehicle of Figure 1; the dash line illustrates the profile contour of the elements after the chassis front has struck an obstacle, with the consequent backward and upward displacement of the power unit and gearbox assembly 5, 6 due to the abutment thereof against the arcuated cross member 11 somewhat bent backwards by the impact.

55 During the vehicle movement, the concentration of the bearing reactions due to the main engine mountings at nodal points 13, together with the thrust or traction reactions exerted by the set of front wheels through the thrust links 9, is such that it limits considerably the transmission of the possible effects of these actions, such as elastic distortion and vibration, to the chassis elements 2 and 3 disposed in a substantially neutral position where the vibration is reduced between these sources producing mechanical strain and vibrations. The inertia of the mass of the power unit and transmission mechanism assembly tends in all cases to counteract the action of the front driving wheels in opposite directions, thus causing a mutual compensation of their reaction at said points 13.

60 The vertical reaction F of the suspension against the bearing or junction point 29 (Figure 3) is resolved into two forces: F₁ in the

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longitudinal direction of upright 28, and F_2 at right angles thereto. In case of considerable stresses beyond the capacity of suspension 8, the inherent elasticity of upright 28 will assist in absorbing the component F_2 of these stresses, by a bending of the upright relative to its built-in junction to the longitudinal member 2 and cross member 11.

The positioning of the bearing points of the engine 5 at 13, that is, at the top of the curved portion 12 of longitudinal members 2 is such that the engine mounting points are raised to the uppermost permissible level, the bearing reactions converging to a theoretical point P of theoretical anchoring (Figure 3). This last-mentioned point lies well above the centre of gravity G of the power unit and provides a substantially pendular suspension thereof.

Thus, in the case of a front crash, the energy thereof may be absorbed by the thrusting of the cross member 10 and a torsion of the oblique ends 2₁ of the upper longitudinal members 2 without endangering the mechanical components of the vehicle.

A stronger shock will subsequently buckle the upper longitudinal members 2 at points 13, the portion 2₁ being thus bent downwards so that the front portion of the vehicle is raised accordingly. In the case of impact into an obstacle of relatively moderate height, this lifting effect and the "sledge" shape of the front chassis element facilitates climbing of the obstacle and the corresponding absorption of the shock.

If a greater impact energy is applied to the front of the vehicle, it will be absorbed by the engine 5 itself, after the radiator 4 has been crushed, by bending and shearing the connecting members 13₁ and 14₁. The backward shifting of the engine will cause it to strike the cross member 11 of which the torsion attended by the backward bending thereof will further absorb a considerable amount of energy.

The front portion of the vehicle will then have roughly the configuration shown in dash lines in Figure 4, without causing any distortion of the passengers' compartment. This distortion will occur only at a later stage, in case the front end were "folded" about the junction point 14 as shown diagrammatically in Figure 5 wherein the original shape of the vehicle is shown in dash lines. In this case the structure according to this invention will permit of lifting the power unit and gearbox assembly against the transverse member of the dashboard or facia 30 by pivoting about the end of the gearbox 6 bearing on the ground, thus absorbing an additional amount of energy before the power unit eventually penetrates dangerously into the passengers' compartment.

By way of example, a full-size front crash test carried out with a vehicle having a

chassis-body structure according to this invention, weighing 1,007 kilograms and driven at 30 m.p.h. was attended by a backward thrust of 16.73" of the vehicle front to the wheel axis, the engine receding by 16.15", while the body structure was contracted by 1.85", the total contraction of the total vehicle length being 18.88"; finally, the appearance of the vehicle after the crash was substantially as shown in Figure 5, thus proving the existence of additional possibilities of absorption by accentuating the bending and buckling of the longitudinal members 2 and 3 while tilting the engine against the beam of the dashboard or facia 30.

Under these conditions it is clear that the chassis structure according to this invention is capable of giving to front-engined vehicles a capacity of absorbing front shocks at least equivalent to that hitherto obtained only with rear-engined vehicles.

Although a single form of embodiment of the invention has been shown and described herein, it will readily occur to those conversant with the art that various modifications may be brought thereto without departing from the scope of the invention as set forth in the appended claims.

WHAT WE CLAIM IS:—

1. A chassis-frame structure for an automotive vehicle having a front power unit and transmission mechanism assembly and front wheel drive, the front wheels being connected through thrust links to the chassis frame, the chassis-frame structure comprising a compound chassis consisting of an assembly of three main elements, that is, a first or front element constituted by a pair of lower parallel longitudinal members upswept at their front ends, and by a pair of upper longitudinal members each rigidly assembled at two junction nodes with one of said lower longitudinal members to provide a cradle for the power unit, transmission mechanism assembly and the front wheels, each said upper longitudinal member having an upswept curved portion and an out-swept forward extension beyond said lower longitudinal members, the front ends of the forward extensions being interconnected by a curved horizontal cross member, said lower longitudinal members each having a rear extension, the second element consisting of an intermediate chassis member in the form of a steel pressing formed with pressed reinforcing ribs and constituting a floor of a passenger's compartment and comprising pressed wells for the feet of rear seat passengers, and finally a third or rear element consisting of a pair of parallel longitudinal members having a spacing different to that of said front longitudinal members.

2. A chassis-frame structure according to claim 1, wherein a first of said two junction nodes interconnects the top of the upswept



longitudinal direction of upright 28, and F_2 at right angles thereto. In case of considerable stresses beyond the capacity of suspension 8, the inherent elasticity of upright 28 will assist in absorbing the component F_2 of these stresses, by a bending of the upright relative to its built-in junction to the longitudinal member 2 and cross member 11.

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2. A chassis-frame structure according to claim 1, wherein a first of said two junction nodes interconnects the top of the upswept

- 5 curved portion of the upper longitudinal member and the front end of the associated lower longitudinal member, and the second of said two junction nodes interconnects the rear end of the upper longitudinal member and a portion of the associated lower longitudinal member which is located at the rear of said cradle.
- 10 3. A chassis-frame structure according to claim 1 or claim 2, wherein the rear ends of the upper longitudinal members and the rear extensions of the lower longitudinal members of the front element of the chassis are rigidly connected to the steel pressing constituting the intermediate chassis element and the floor of the passengers' compartment, said rear portions of the lower longitudinal members extending under said pressing, their rear ends being rigidly connected to the front walls of said wells formed in said pressing.
- 15 4. A chassis-frame structure according to any one of the preceding claims, wherein the front portions of the rear longitudinal members constituting said third or rear element extend under the steel pressing of said intermediate element and the front ends of said rear longitudinal members are rigidly connected to the rear walls of said wells formed in said pressing.
- 20 5. A chassis-frame structure according to claim 2, wherein the front junction nodes of the upper and lower front longitudinal members are arranged to receive the main bearing points of the power unit and transmission mechanism assembly, and the bearing points of said thrust links, the other junction nodes of the front longitudinal members receiving furthermore secondary bearing points of the power unit and transmission mechanism assembly.
- 25 6. A chassis-frame structure according to any one of the preceding claims, wherein a bow-shaped cross member interconnects the pair of upper front longitudinal members behind the upswept curved portions, said cross member having at its ends oblique nearly vertical built-in uprights arranged to receive at their upper ends bearing points of front wheel suspension elements of the vehicle.
- 30 7. A chassis-frame structure according to any one of the preceding claims, wherein a fuel tank having a flat and reinforced top constitutes the floor of a boot for the vehicle and is rigidly fitted between said pair of rear longitudinal members.
- 35 8. A chassis-frame structure substantially as described hereinabove with reference to the accompanying drawing.
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