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GB 1206335 A GB 0981853 A GB 0598754 A
GB 0407974 A GB 0225347 A

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(54) **Power unit support**

(57) A power unit supporting apparatus for supporting on a vehicle body a power unit (P) comprising an engine portion (E) having a longitudinal crankshaft and a lateral drive shaft (S), said apparatus comprising first resilient support means (4) for resiliently supporting on the vehicle body one end of the power unit which is further from the vehicle compartment, second resilient support means (5) for resiliently supporting on the vehicle body an intermediate portion of the power unit, the center of gravity (G) of the power unit being located between said one end and said intermediate portion of the power unit, and displacement defining means (6) provided between the other end of the power unit which is closer to the vehicle compartment and the vehicle body to resiliently restrain vertical displacement of said other end of the power in excess of a predetermined amount, the spring constants of the first and second resilient support means may be relatively large in the vertical direction of the power unit and relatively small in rolling direction of the power unit. Rolling vibration of the power unit is thereby effectively absorbed during idling, whilst the pitching amplitude of the power unit is effectively restrained during load operation.

FIG.1

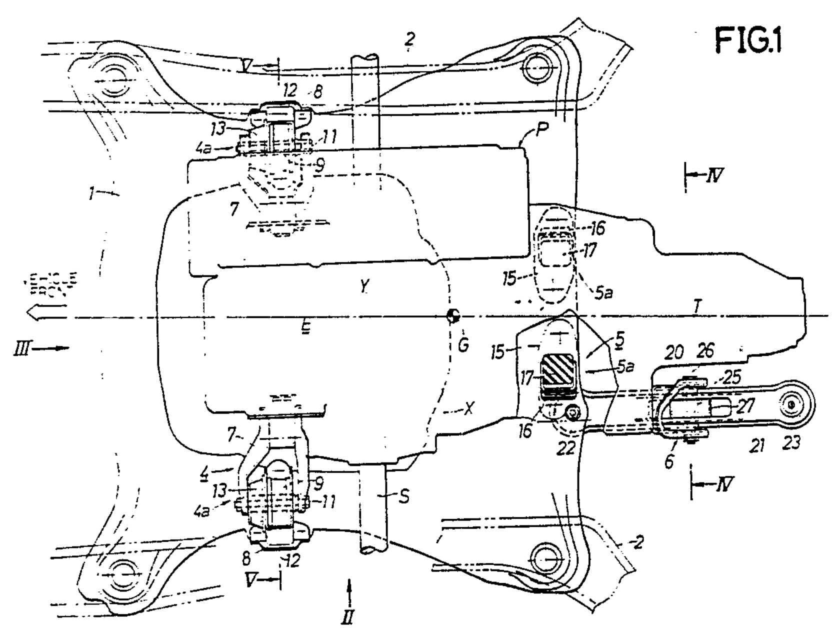

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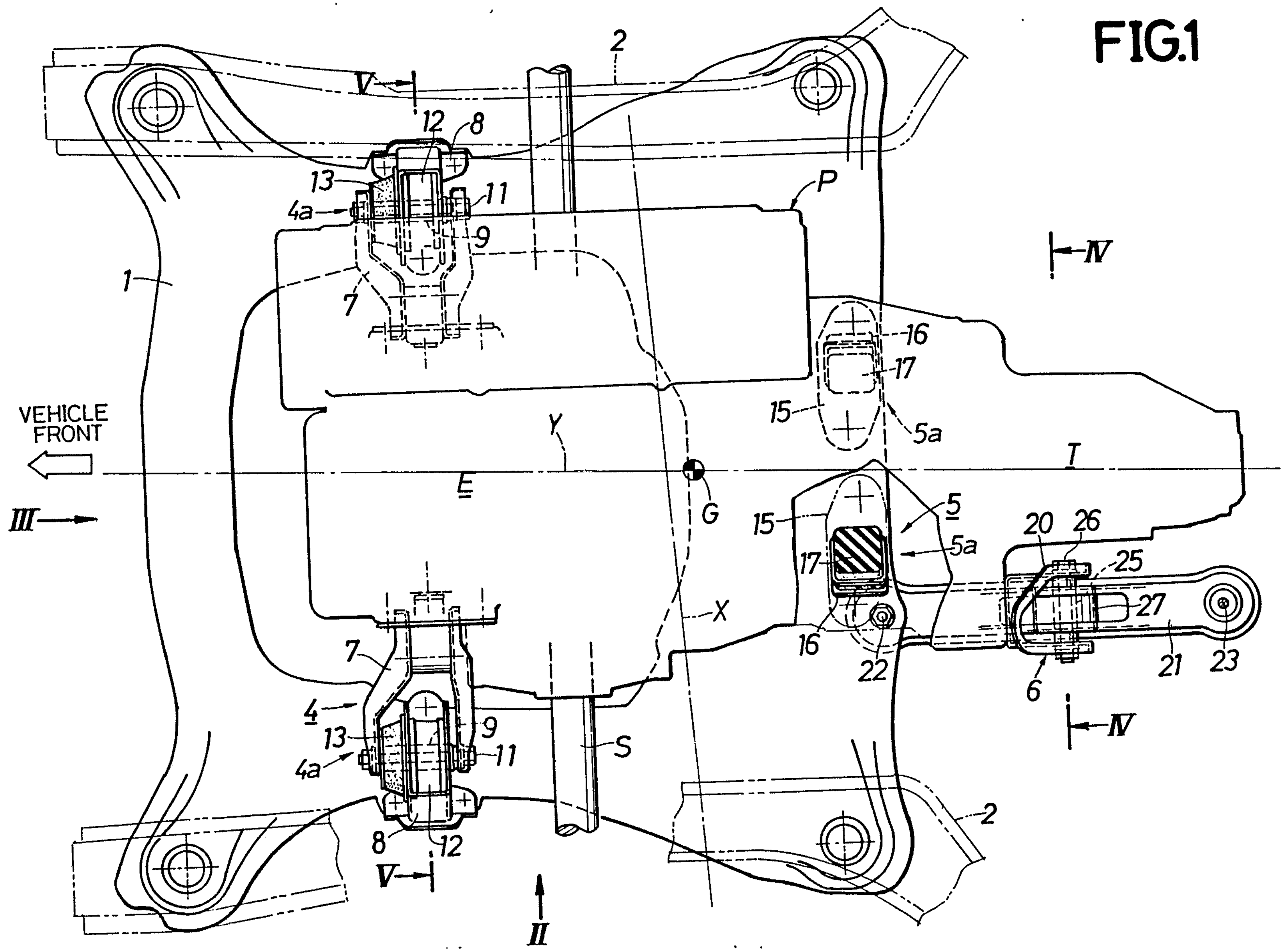
FIG.1


VEHICLE FRONT
III
II
IV
V
1
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11
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FIG.2

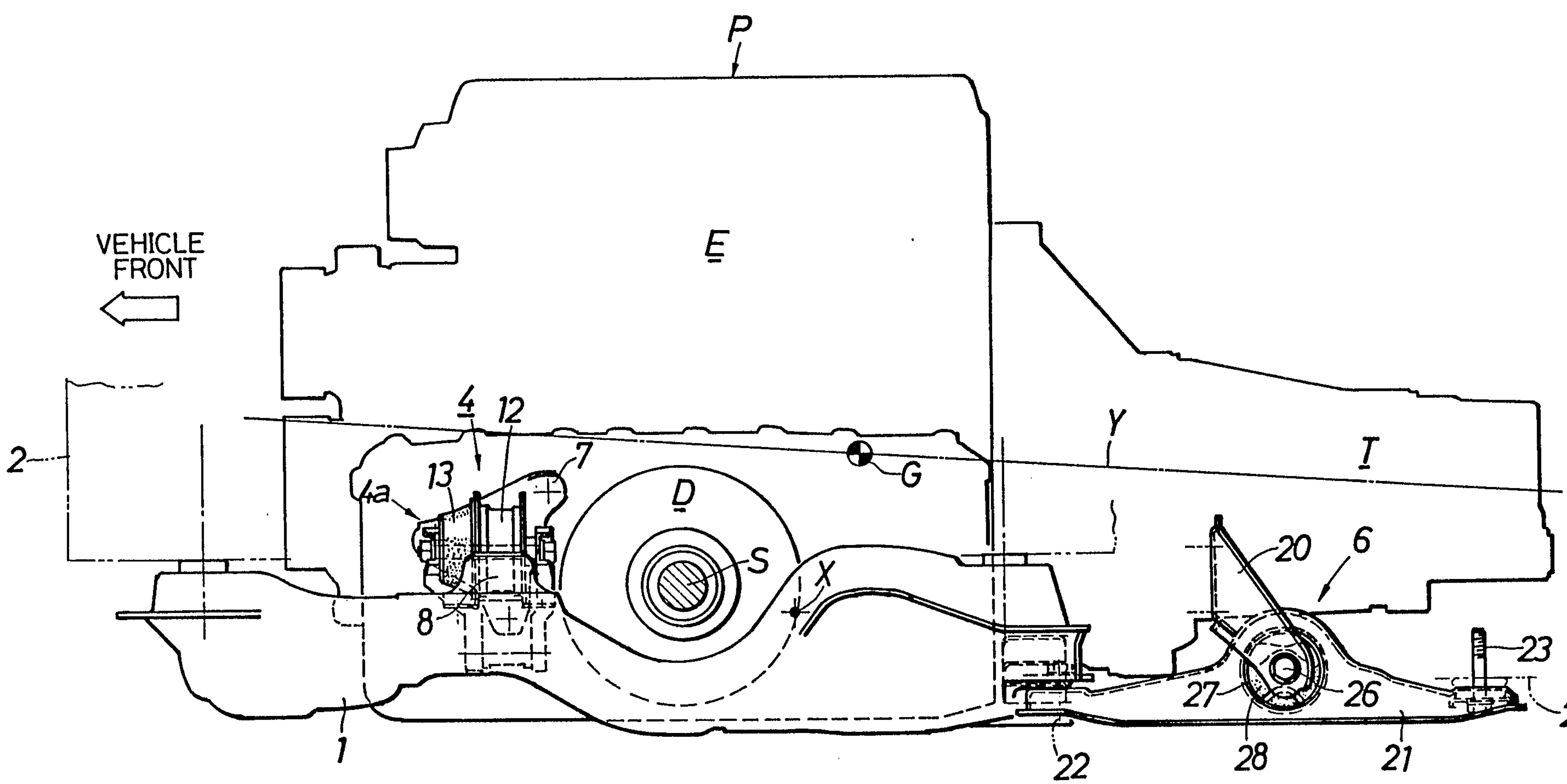


FIG.3

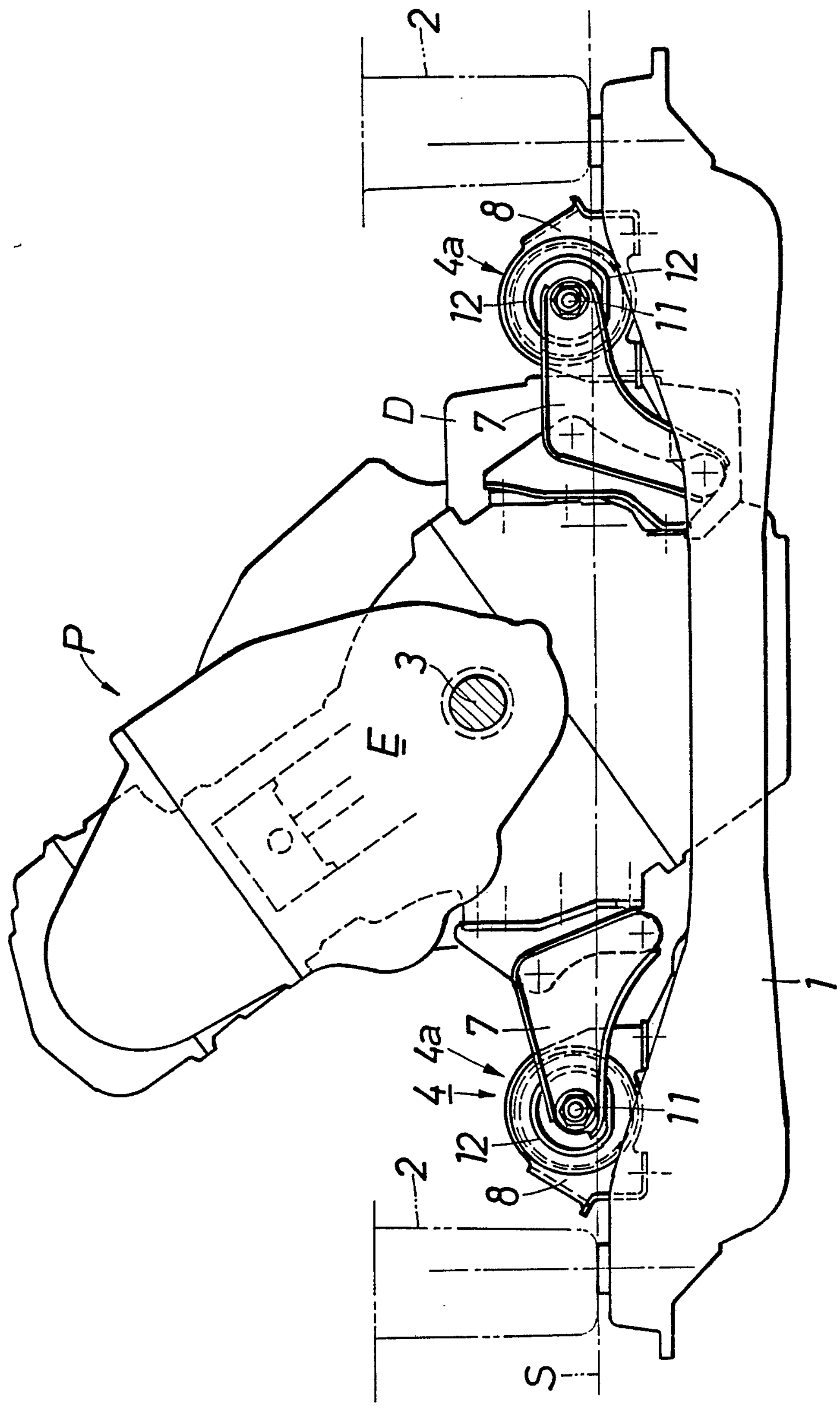
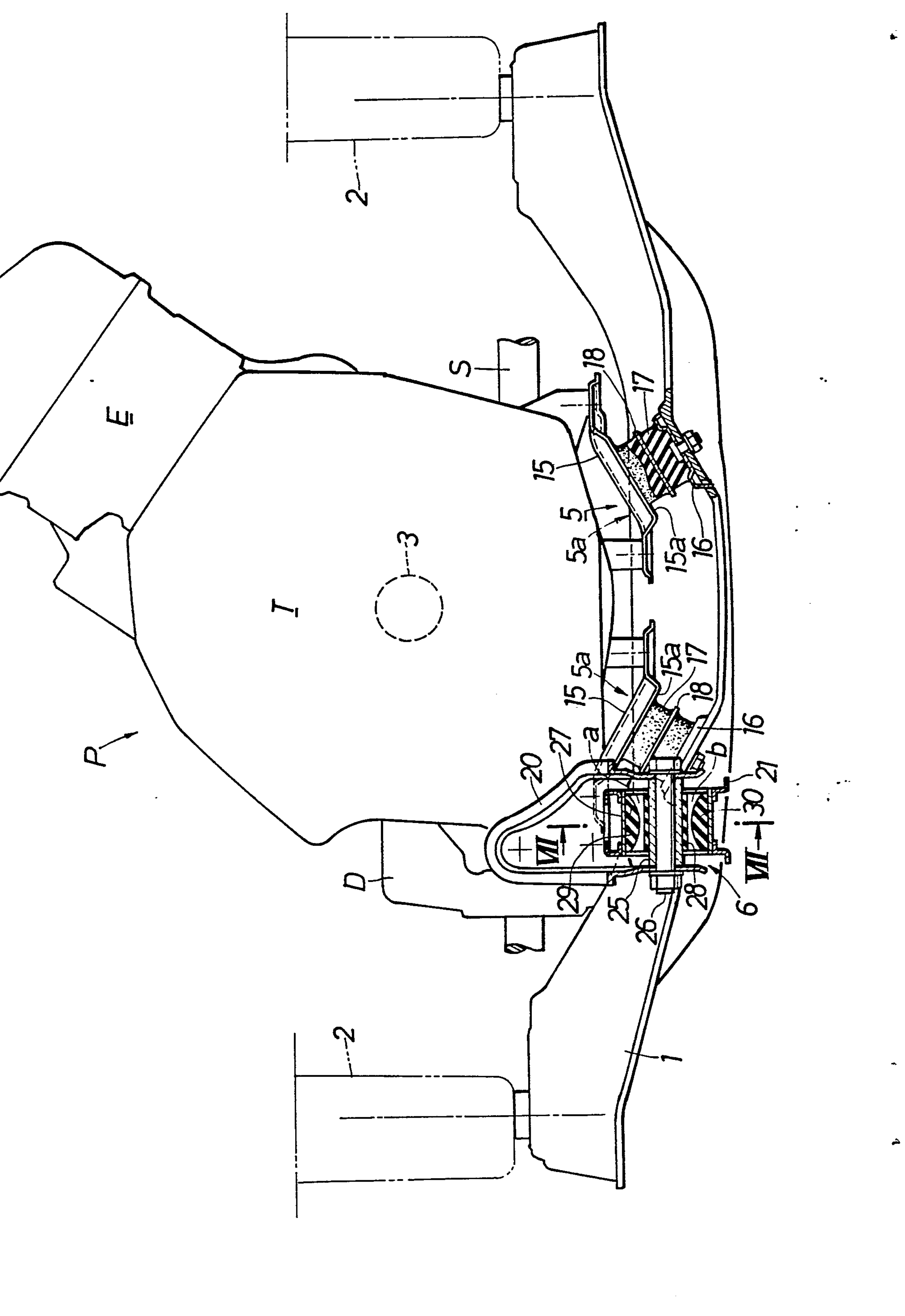


FIG.4



P
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I
3
S
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2
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5a
15
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15a
15a
16
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29
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b
6
VII
VII

FIG.5

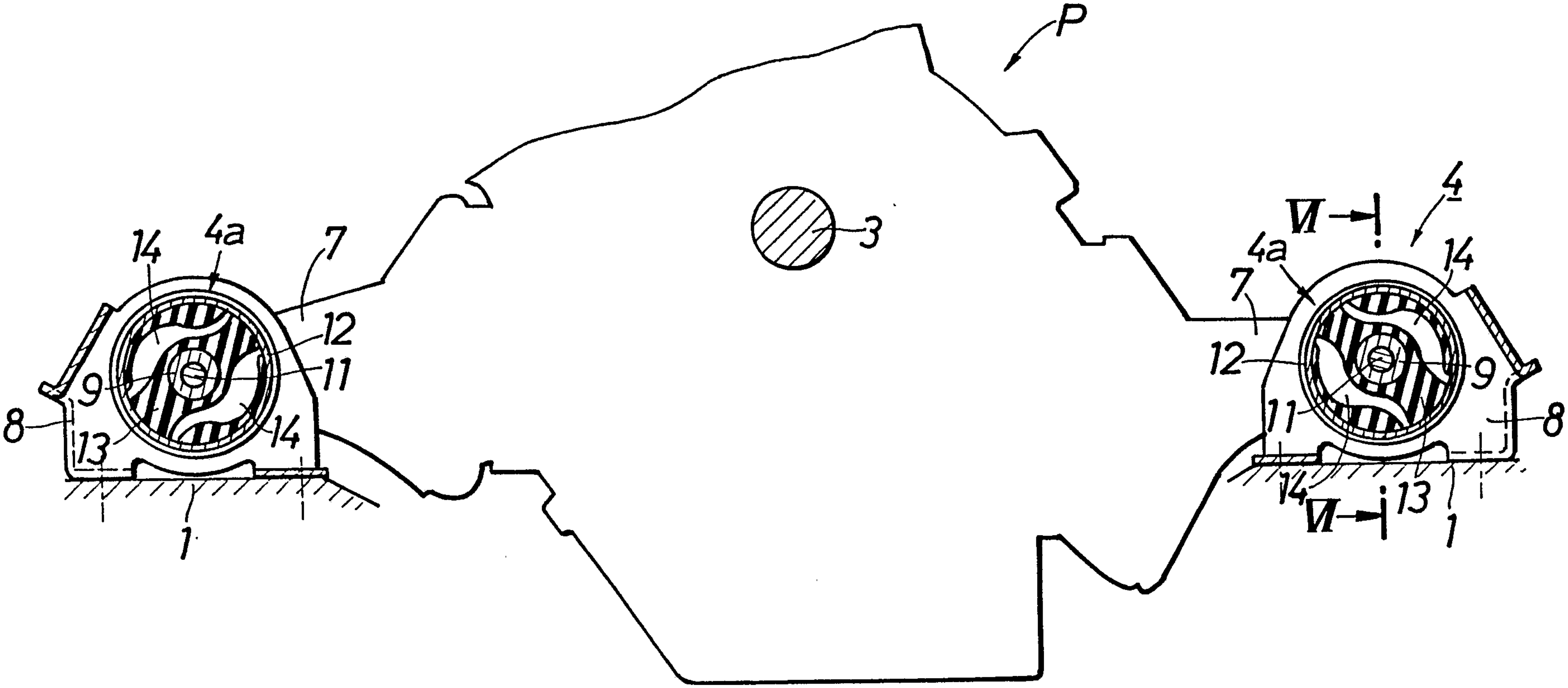


FIG.6

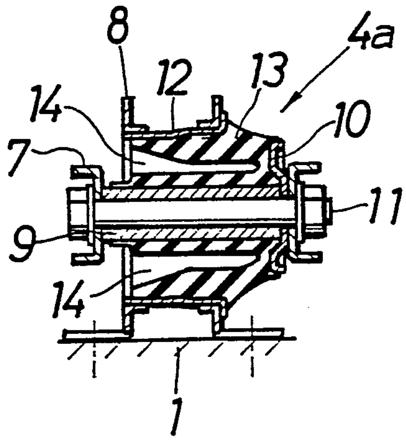


FIG.7

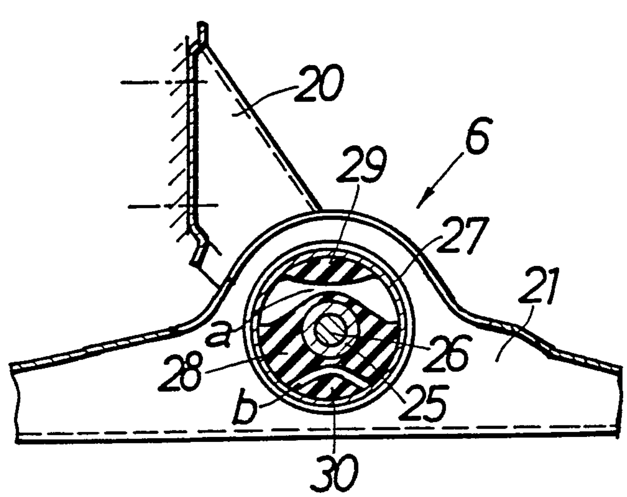


FIG.8

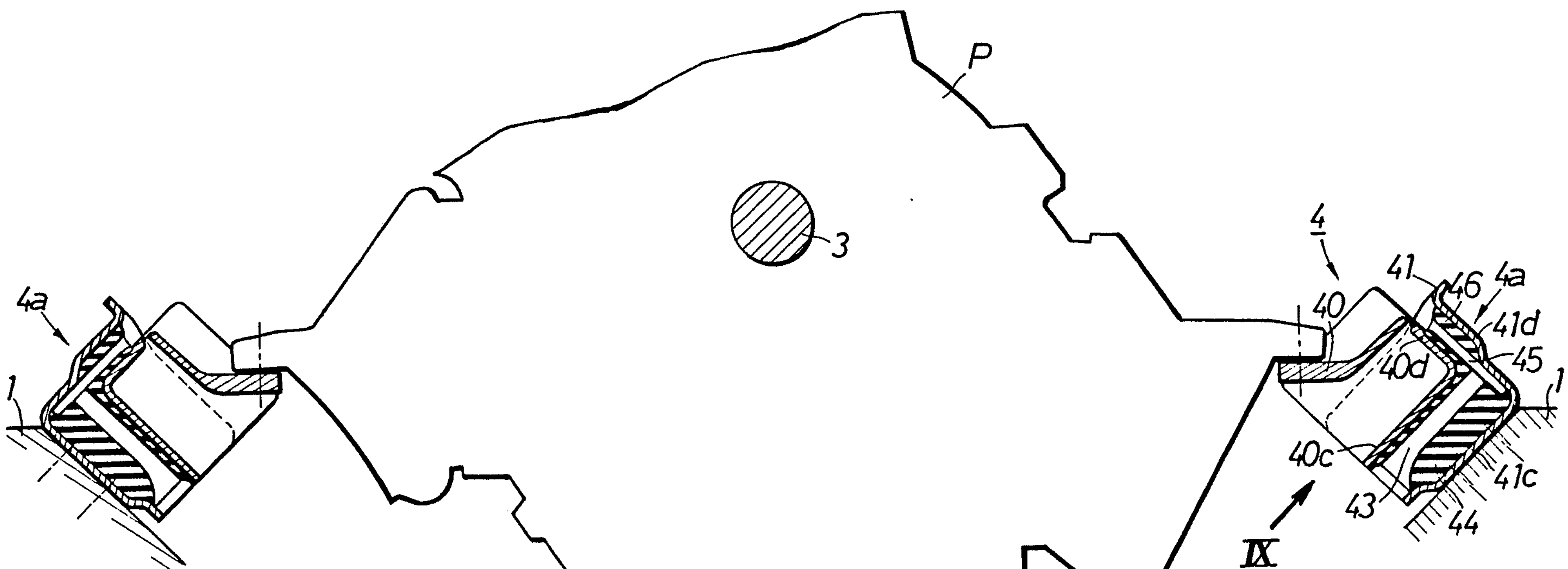
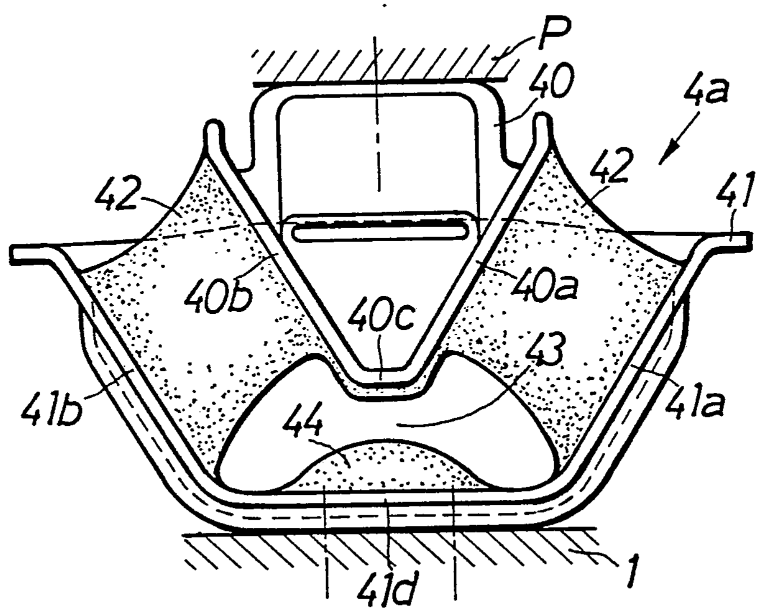


FIG.9



55-802.520

POWER UNIT SUPPORTING APPARATUS FOR VEHICLE

This invention relates to a power unit supporting apparatus for a vehicle such as an automobile, for supporting a power unit comprising an engine portion in which a crankshaft is arranged in the longitudinal direction of the vehicle body, a transmission portion provided at one end of the engine portion in the longitudinal direction of the vehicle body, and a drive shaft disposed below the engine portion and extending in the lateral direction of the vehicle body for driving wheels.

In the past, in power unit supporting apparatus of this kind, a power unit has been supported at front and rear ends thereof on a vehicle body by respective resilient support means (see Japanese Utility Model Application Laid-Open No. 61225/86).

However, a power unit of the type in which an engine portion having a crankshaft arranged in a longitudinal direction of the vehicle body is provided at one end of the engine portion with a transmission portion, is lengthy in the longitudinal direction of the vehicle body. As a result, there is a problem that when the power unit is supported at the front and rear ends thereof on the vehicle body as mentioned above, one support portion comes very close to the compartment of the vehicle, and as a result vibrations of the power unit are transmitted to the compartment during operation, to reduce the comfort of the occupants.

Thus an object of the present invention is to provide a power unit supporting apparatus of the above type which can more effectively restrain transmission of vibrations of the power unit to the vehicle compartment.

According to the present invention there is provided a power unit supporting apparatus for supporting on a vehicle body a power unit comprising an engine portion in which a crankshaft is arranged in the longitudinal direction of the vehicle body, a transmission portion provided at one end of the engine portion in the longitudinal direction of the vehicle body, and a drive shaft disposed below the engine portion and extending in the lateral direction of the vehicle body for driving wheels, said supporting apparatus comprising first resilient support means for resiliently supporting on the vehicle body one end of the power unit which is further from the vehicle compartment, second resilient support means for resiliently supporting on the vehicle body an intermediate portion of the power unit, the center of gravity of the power unit being located between said one end and said intermediate portion of the power unit, and displacement defining means provided between the other end of the power unit which is closer to the vehicle compartment and the vehicle body to resiliently restrain vertical displacement of the said other end of the power unit in excess of a predetermined amount, the spring constants of said first and second resilient support means being relatively large in a vertical direction of the power unit and relatively small in a rolling direction thereof.

With such an arrangement, even if the power unit vibrates in the rolling direction during idling, the first and second resilient support means exhibit the characteristic of the small spring constant so as to well absorb the vibration, whereas the said displacement defining means freely allows the vibration of the power unit so as effectively to cut off the transmission of vibration from the power unit to the vehicle body. Particularly, it is possible to prevent vibration of the power unit from being transmitted to the vehicle compartment through the displacement defining means.

Furthermore, even if the power unit vibrates in the pitching direction during load-operation, the first and second resilient support means exhibit the characteristic of a large spring constant and thereby effectively prevent the power unit from floating up, so that the amplitude of the power unit can be restrained to a small level. If the amplitude exceeds a certain value, the displacement defining means operates to restrain excessive increase of the amplitude in a buffering manner.

Particularly, since the displacement defining means is located far away from the drive shaft, the load received by the displacement defining means is relatively small. Accordingly, pitching of the power unit can be effectively restrained by the displacement defining means, and there is less transmission of vibration from the power unit to the compartment through the displacement defining means.

An embodiment of the invention, together with a modification thereof, will now be described by way of example and with reference to the accompanying drawings, in which:-

Fig. 1 is a plan view of a power unit supporting apparatus, partially cutaway;

Fig. 2 is a view taken on arrow II of Fig. 1;

Fig. 3 is a view taken on arrow III of Fig. 1;

Fig. 4 is a sectional view taken on line IV - IV of Fig. 1;

Fig. 5 is an enlarged sectional view taken on line V - V of Fig. 1;

Fig. 6 is a sectional view taken on line VI - VI of Fig. 5;

Fig. 7 is a sectional view taken on line VII - VII of Fig. 4;

Fig. 8 is a sectional view similar to Fig. 5 showing a modified form of first resilient support means; and

Fig. 9 is a view as seen in the direction of arrow IX of Fig. 8.

Referring first to Figs. 1 to 3, a power unit P for an FF (front engine and front drive) automobile is supported, in an engine space formed in front of a compartment of the vehicle, on a substantially square shaped sub-frame 1 which constitutes a part of a vehicle body. The sub-frame 1 is fixed at four corners thereof to front side frame portions 2 of the vehicle body through elastic members made of a material such as rubber.

The power unit P comprises an engine portion E in which a crankshaft 3 is arranged in the longitudinal direction of the vehicle body, a transmission portion T provided at the rear end of the engine portion E, a differential gear portion D provided on one side of a lower portion of the engine portion E, and a drive shaft S protruding from both the left and right sides of the differential gear portion D and connected to left and right front wheels (not shown). A rear half portion of the transmission portion T is received in a tunnel portion formed in a floor plate of the compartment.

The power unit P is supported on the sub-frame 1 at a front end of the power unit by first resilient support means 4, and at an intermediate portion of the power unit, to the rear of the center of gravity G of the power unit, by second resilient support means 5. A displacement defining means 6 which resiliently restrains vertical displacement of the transmission portion T in excess of a predetermined value is provided at the rear end of the power unit P, i.e. between the transmission portion T and the vehicle body in the illustrated example. The drive shaft S is arranged between the center of gravity G and the first resilient support means 4 in a plane.

As shown in Figs. 3, 5 and 6, the first resilient support means 4 comprises a pair of left and right resilient support units 4a and 4a. Each of the resilient support units 4a comprises a bifurcated bracket 7 protruding from one side surface of the front end of the power unit P, and an annular bracket 8 protruding from the upper surface of the sub-frame 1 and disposed within the bifurcated portion of the bracket 7. On the bifurcated bracket 7 are fixedly mounted by bolts 11 an inner cylinder 9 extending through the annular bracket 8 and an end plate 10 adjacent to the front end of the inner cylinder 9. On the annular bracket 8 is fixedly mounted an outer cylinder 12 which concentrically surrounds the inner cylinder 9. An elastic body 13 made of rubber is baked over these inner and outer cylinders 9 and 12 and the end plate 10.

The elastic body 13 is provided with a pair of eyebrow-shaped concave portions 14 and 14 which open to the end surface opposite to the end plate 10 (see Fig. 5). The concave portions 14 and 14 hold the inner cylinder 9 therebetween and are inclinedly arranged so as to become closer to the power unit P as they extend upwards. Each of the eyebrow-shaped concave portions 14 is formed so that the width thereof is narrowest on a vertical line passing through the center of the inner cylinder 9 and is widest at a central portion of the concave portion 14. With this, the overall spring constants of the left and right elastic bodies 13 and 13 in the range in which the concave portion 14 is not deformed are set to be relatively large in the vertical direction of the power unit P, relatively small in a rolling direction, and largest in the longitudinal direction of the power unit P.

As shown in Figs. 1 and 4, the second resilient support means 5 comprises a pair of left and right resilient support units 5a and 5a. Each of the resilient support units 5a comprises an upper bracket 15 secured to the bottom surface of the intermediate portion of the power unit P and a lower bracket 16 opposed to the upper bracket 15 and secured to the upper surface of the sub-frame 1. The upper bracket 15 has a bevel portion 15a which extends downwardly towards the center of the vehicle body. A prism elastic body 17 made of rubber is baked between the bevel portion 15a and the lower bracket 16 parallel therewith. With this, the overall spring constants of the left and right elastic bodies 17 and 17 are set to be relatively large in the vertical direction of the power unit P and relatively small in the rolling direction.

Embedded in each elastic body 17 is a shape-retaining plate 18 extending parallel with the bevel portion 15a, to prevent buckling.

Thus, in the first and second resilient support means 4 and 5, four resilient support units 4a, 4a, 5a and 5a are arranged so as to surround the center of gravity G of the power unit P. Further, the second resilient support means 5 is arranged closer than the first resilient support means 4 to the center of gravity G of the power unit P so that the weight distribution of the power unit P is more on the second resilient support means 5 than on the first resilient support means 4.

As shown in Figs. 2, 4 and 7, the aforementioned displacement defining means 6 comprises an upper bifurcated bracket 20 secured to one side of the transmission portion T and a lower bracket 21 passing through the bifurcated portions of the upper bracket 20 and extending in the longitudinal direction, the lower bracket 21 having a front end secured to the sub-frame 1 by means of a bolt 22 and a rear end secured to a floor portion 24 of the vehicle body by means of a bolt 23.

An inner cylinder 25 which interconnects the bifurcated portions of the upper bracket 20 and extends in the lateral direction of the vehicle body is secured to the upper bracket 20 by means of a bolt 26. An outer cylinder 27 which concentrically surrounds the inner cylinder 25 is fitted to the lower bracket 21. A bent plate-like elastic body 28 made of rubber and raised at a middle portion thereof is baked between the inner and outer cylinders 25 and 27. The spring constant of the elastic body 28 in the vertical direction of the power unit P is set to be much smaller than that of the other elastic bodies 13 and 17 in the same direction.

Baked to the outer cylinder 27 are a pair of upper and lower elastic stoppers 29 and 30 which are opposed to the central portion of the elastic body 28 but leaving predetermined gaps a and b. Accordingly, the central portion of the elastic body 28 can come into contact with the elastic stoppers 29 and 30, whereby the upward and downward displacements of the transmission portion T are resiliently restrained.

Preferred examples of spring constants of the elastic bodies 13, 17 ad 28 are given below.

	Vertical	Lateral	Longi-tudinal
Elastic body 13 (two)	38 kgf/mm	38 kgf/mm	70 kgf/mm
Elastic body 17 (two)	40 "	22 "	12 "
Elastic body 28	20 "	7 "	25 "

The operation of this embodiment will be described hereinafter.

During idling, the power unit P vibrates around the rolling axis Y due to a rotational variation of the crankshaft 3. Since the spring constants of the elastic bodies 13 and 17 of the first and second resilient support means 4 and 5 are relatively small, these elastic bodies 13 and 17 can be easily deformed so as to well absorb the vibration.

On the other hand, since the elastic body 28 of the displacement defining means 6 is very small in spring constant in the vertical and lateral directions, the elastic body 28 is very easily deformed in this range and does not contact the elastic stoppers 29 and 30, thereby allowing the aforesaid rolling vibration with little resistance. Accordingly, even if the displacement defining means 6 comes close to the vehicle compartment, there occurs hardly any vibration which is transmitted from the power unit P to the compartment through the means 6.

The power unit P vibrates around the pitching axis X due to the drive reaction of the drive shaft S during low and medium load operations. This vibration acts as a vertical vibration on the elastic bodies 13 and 17 of the first and second resilient support means 4 and 5. The spring constant of each of the elastic bodies 13 and 17 is relatively large in that vertical direction. Therefore, each of the elastic bodies 13 and 17 acts reliably against floating up of the power unit P, so as to restrain the amplitude thereof to a small level. Moreover, in the range where the pitching amplitude of the power unit P is small, the elastic body 28 of the displacement defining means 6 does not contact the elastic stoppers 29 and 30. Therefore, in this case also, there occurs hardly any vibration which is transmitted from the power unit P to the vehicle compartment through the means 6.

In the displacement defining means 6, when the pitching amplitude of the power unit P exceeds a predetermined value during high load operation, the central portion of the elastic body 28 comes into contact with the elastic stopper 29 or 30 whereby an excessive increase of the amplitude is restrained without being accompanied by shocks. Moreover, since the displacement defining means 6 is located far away from the drive shaft S, the load applied to the elastic stopper 29 or 30 is relatively small. Thus the increase in the pitching amplitude of the power unit P can be effectively restrained without placing a burden on the elastic stoppers 29 and 30, and the transmission of vibration from the power unit P to the compartment through the displacement defining means 6 can be reduced.

The whole power unit P vibrates vertically during travelling on a bad or rough road. The spring constant of each of the elastic bodies 13 and 17 of the first and second resilient support means 4 and 5 is relatively large in that vertical direction, and therefore the vertical amplitude of the power unit P is restrained to a small level. Since, in the displacement defining means 6, the central portion of the elastic body 28 is easily deformed in the range where it does not contact the elastic stoppers 29 and 30, there occurs hardly any transmission of vibration to the vehicle compartment.

Since the center of gravity G of the power unit P is positioned to the rear of the drive shaft S, the power unit P is of a so-called midship type, contributing to an improvement in performance of motion of the vehicle.

Figs. 8 and 9 show a modified form of the first resilient support means 4. In this case, the first resilient support means 4 also comprises a pair of left and right resilient support units 4a and 4a. Each resilient support unit 4a comprises an inner bracket 40 secured to one side of the front end of the power unit P and an outer bracket 41 secured to the upper surface of the sub-frame 1 and arranged so as to hold the inner bracket 40.

The inner bracket 40 has front and rear walls 40a and 40b opened in the form of V. The inner bracket 40 is arranged so that a ridge line portion 40c between the walls 40a and 40b extends downwardly towards the center of the vehicle body. The walls 40a and 40b are connected together at their upper ends by a connecting wall 40d.

On the other hand, the outer bracket 41 is of a groove form in which a portion opposed to the ridge line portion 40c is a bottom wall 41c, and front and rear walls 41a and 41b thereof are arranged parallel with the front and rear walls 40a and 40b of the inner bracket 40. The walls 41a and 41b are also connected at upper ends therefor by a connecting wall 41d. This connecting wall

41d is arranged to be opposed to the connecting wall 40d at the upper portion thereof.

Elastic bodies 42 and 42 are baked between the opposed front walls 40a and 41a and between the rear walls 40b and 41b, respectively. Baked on the outer bracket 41 is a first elastic stopper 41 opposed to the ridge line portion 40c of the inner bracket 40 and leaving a predetermined gap 43. Also, baked on the connecting wall 41d of the outer bracket 41 is a second elastic stopper 46 opposed to the connecting wall 40d of the inner bracket 40 and leaving a predetermined gap 45.

In the above described construction of the resilient support unit 4a, the elastic bodies 42 and 42 and the elastic stoppers 44 and 46 can be molded in one step by pattern draw molding only in two directions.

The first elastic stopper 44 carries the ridge line portion 40c of the inner bracket 40 to delimit the downward displacement of the power unit P when it is more than a predetermined level, and the second elastic stopper 46 carries the connecting wall 40d of the inner bracket 40 to delimit the displacement of the power unit P when it is more than a predetermined level in the rolling direction, upward and lateral directions. The overall spring constants of the left and right elastic support units 4a and 4a in the range in which the elastic stoppers 44 and 46 do not operate are the same as those of the previous embodiment.

In the above-described embodiments, although the first and second resilient support means 4 and 5 comprise pairs of left and right resilient support units 4a, 4a; 5a, 5b respectively, it is to be noted that one of the resilient support means 4 or 5 could comprise a single resilient support unit arranged on a longitudinal center line of the power unit P. Of course, each of the resilient support means 4 and 5 can be composed of three or more resilient support units. Furthermore, although in the above-described embodiments the displacement defining means 6 has been arranged below the side of the transmission T, it is to be noted that if an extra space is available, the means 6 can be arranged just below or just behind the transmission T.

Furthermore, the present invention can be applied also to an RR (rear engine and rear drive) type automobile, in which case the displacement defining means 6, the second resilient support means 5 and the first resilient support means 4 are arranged in that order from the front.

CLAIMS

1. A power unit supporting apparatus for supporting on a vehicle body a power unit comprising an engine portion in which a crankshaft is arranged in the longitudinal direction of the vehicle body, a transmission portion provided at one end of the engine portion in the longitudinal direction of the vehicle body, and a drive shaft disposed below the engine portion and extending in the lateral direction of the vehicle body for driving wheels, said supporting apparatus comprising first resilient support means for resiliently supporting on the vehicle body one end of the power unit which is further from the vehicle compartment, second resilient support means for resiliently supporting on the vehicle body an intermediate portion of the power unit, the center of gravity of the power unit being located between said one end and said intermediate portion of the power unit, and displacement defining means provided between the other end of the power unit which is closer to the vehicle compartment and the vehicle body to resiliently restrain vertical displacement of said other end of the power unit in excess of a predetermined amount, the spring constants of said first and second resilient support means being relatively large in a vertical direction of the power unit and relatively small in a rolling direction thereof.

2 Apparatus as claimed in claim 1, wherein said second resilient support means is disposed closer than the first resilient support means to the center of gravity of the power unit.

3. Apparatus as claimed in claim 1 or 2, wherein the said power unit is for a front engine and front drive automobile, and the said drive shaft is disposed so that an axis thereof crosses between the first resilient support means and the center of gravity of the power unit

in a plane.

4. Apparatus as claimed in claim 1, substantially as hereinbefore described with reference to Figures 1 to 7 of the accompanying drawings.

5. Apparatus as claimed in claim 4 but modified substantially as hereinbefore described with reference to Figures 8 and 9 of the accompanying drawings.

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