June 24, 1930. R. SARDESON ET AL 1,767,015

RESILIENT ENGINE MOUNTING

Filed Aug. 3, 1927 2 Sheets-Sheet 1

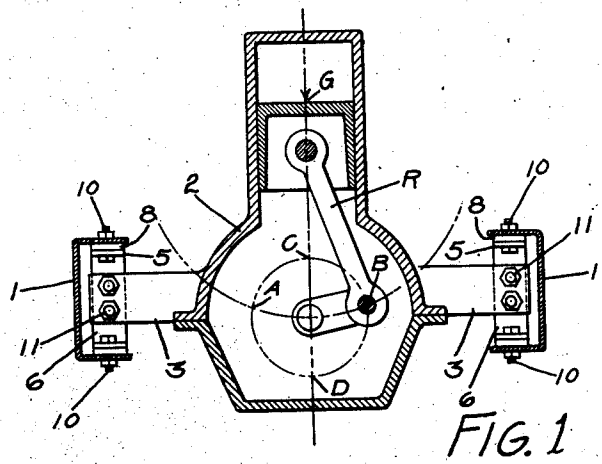


FIG. 1

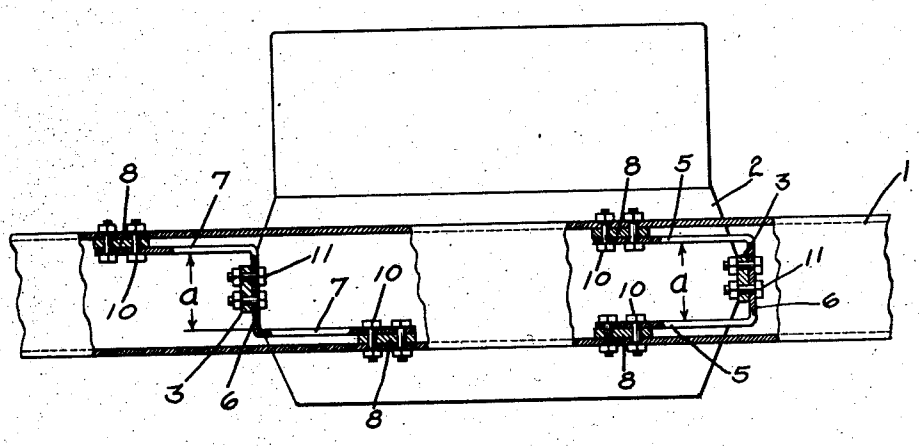


FIG. 2

FIG. 3

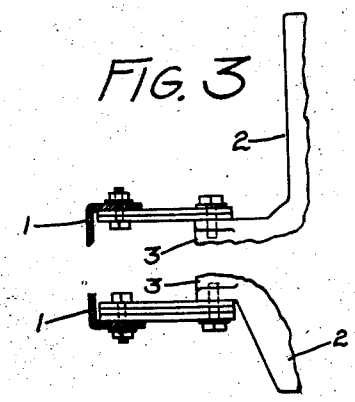


FIG. 4

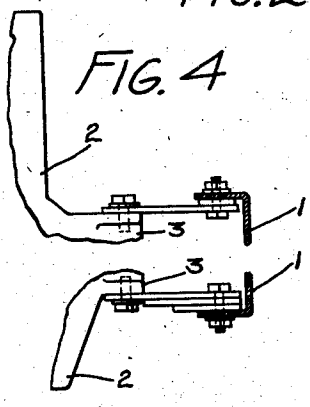


FIG. 5

FIG. 6

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RESILIENT ENGINE MOUNTING

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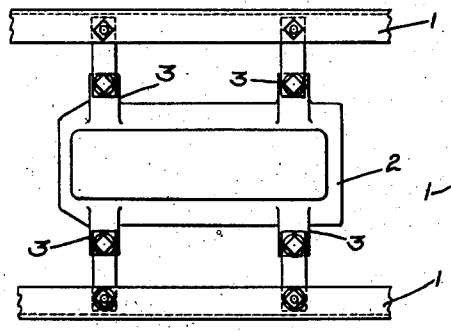


FIG. 7

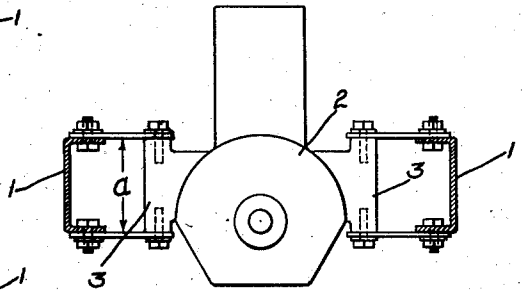


FIG. 8

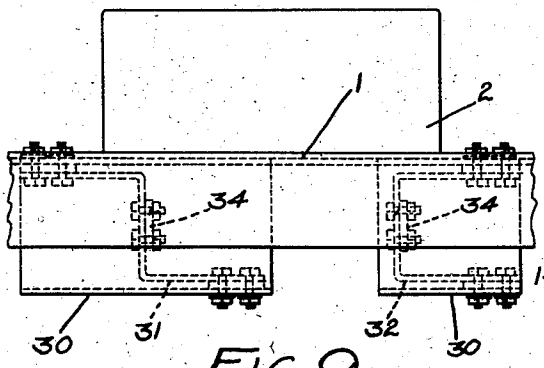


FIG. 9

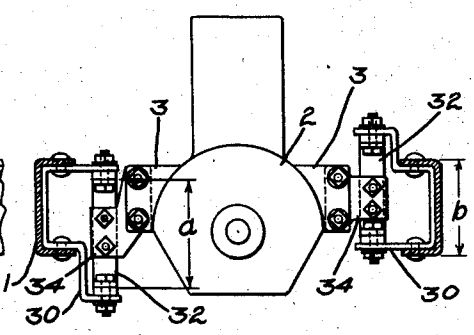


FIG. 10

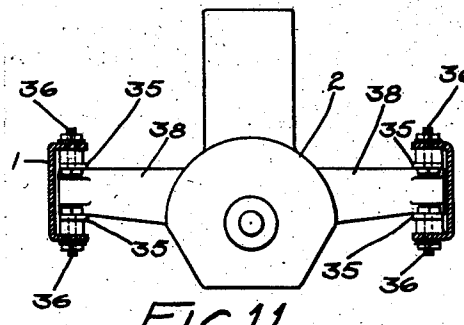


FIG. 11

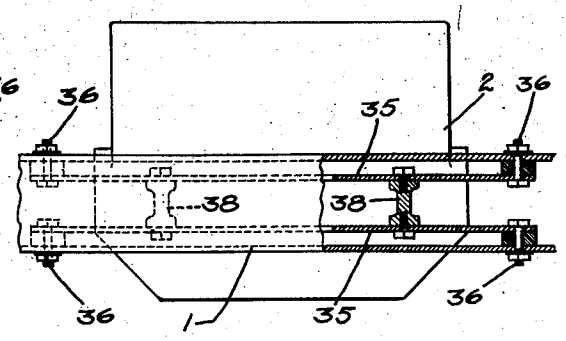


FIG. 12

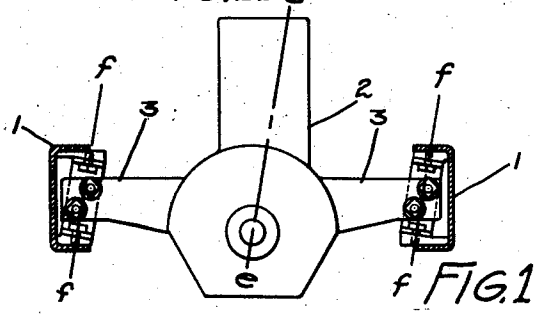


FIG. 13

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RESILIENT ENGINE MOUNTING

Application filed August 3, 1927. Serial No. 210,338.

This invention relates to improvements in engine mountings particularly engine mountings for automobiles, the main object being to provide means for resiliently supporting the engine upon its frame in a manner to prevent the usual shocks and vibrations of the engine from being transmitted to the car-chassis, and, at the same time, substantially eliminating the usual rotative or rocking action of the engine, which commonly exists when the engine is mounted upon the usual type of resilient mounting. It will be understood that the high speed vibration is principally caused by unequal accelerative forces of the reciprocating parts, particularly the top and bottom portions of the strokes. The present invention makes use of resilient elements arranged to be relatively flexible in direction of vibratory motion, but further arranged to be relatively stiff in other directions, such as rotative or rocking motions, said elements being placed in certain spaced relations to oppose such rotative motions, caused by engine impulses.

To those who are familiar with four cylinder automobile engines, it is well known that vibrations are set up by the reciprocating parts which are not only injurious to the chassis and body of the automobile, but which also disagreeably affect the passengers. By properly connecting the motor to the chassis, however, it is possible to have the engine absorb substantially all of these vibrations within itself, and thus prevent transference of the vibrations in the manner above mentioned. Various means have been employed in an attempt to prevent transference of the vibrations, but all have been found objectionable particularly because when the engine is laboring, a twisting or rocking motion is given thereto.

In certain multiple cylinder engines, particularly those of six and twelve cylinders, there are theoretically no unbalanced forces sufficient to cause the motor to exert noticeable vibratory forces upon its mounting. In actual practice, however, there is always some vibration set up due to lack of mechanical perfection, but such vibration ordinarily occurs at such high frequencies that it has more the nature of sound. The present invention has been found of value in preventing the transmission of these high frequency vibrations to the car body, and its resistance to the rocking forces set up in all engines is of value regardless of the number of cylinders.

The present device broadly provides a resilient engine support and mounting relatively free to move in a predetermined path, but having a marked resistance to motion in all other directions. It is particularly designed to resist all rotative or rocking motion of the engine, and, while vertical motions are allowed, lateral motions are allowed only in a very small degree.

Features of the invention include the arrangement of the springs in different planes; their aligned arrangement in direction transversely of the chassis and engine; their aligned arrangement in direction parallel with the long dimension of the engine and chassis; the arrangement in parallel superposed relation; the arrangement of the arms of a given spring in vertically spaced superposed relation; the arrangement of the arms of a given spring in vertically spaced but non-superposed relation; the arrangement of the arms of the spring in spaced relation upon a line which is at an angle to the vertical; the arrangement of the elements within the side rails of the chassis; the arrangement of the elements laterally of the side rails of the chassis, and extending above and below the same; and, generally, to all the details of construction including the use of springs of laminated and non-laminated types.

Objects, advantages and features of the invention are clearly set forth in the following description of the drawings forming a part of this application and in said drawings:

Figure 1 is a vertical transverse section through a chassis showing an engine mounted in accordance with the teachings of this invention, and further illustrating how the rocking vibration in an engine is developed;

Figure 2 is an elevation from the outer side of the chassis, partly broken away to show the improved connections;

Figure 3 is a fragmentary view showing a modification in which laminated elements are

used, and in which the elements are arranged with their long dimension perpendicular to the long dimension of the chassis and engine;

Figure 4 is a view similar to Figure 3 in which single elements are used;

Figure 5 is a similar view showing laminated springs composed of three elements;

Figure 6 is a view similar to Figures 3, 4 and 5 but showing a type of spring which simulates the ordinary leaf spring;

Figure 7 is a plan view with the springs arranged in correspondence to the arrangement shown in Figures 3, 4, 5 and 6;

Figure 8 is a vertical transverse section through the chassis showing a mounting in which four single spring elements are shown, each pair on opposite sides of the engine being aligned transversely or perpendicular to the long axis of the engine and chassis, the springs being connected at the outer side of the side rails of the chassis;

Figure 9 illustrates how the springs can be connected when the vertical height between their elements is greater than the corresponding dimension of the side rails, the type of spring here used being similar to that shown in Figures 1 and 2;

Figure 10 is a vertical transverse section through the chassis further illustrating the construction of Figure 9;

Figure 11 is a vertical transverse section through the chassis showing a modification in which single springs are used, a pair vertically superposed and spaced on each side of the engine, and extending in a direction substantially parallel with the long axis of the engine;

Figure 12 is a side elevation partly in section and further illustrating the construction of Figure 11; and

Figure 13 illustrates how the springs are arranged when the major axis of the vibratory path of the motor is not vertical, or is not exactly parallel to the direction of piston travel.

Vibrations due to lateral rocking motions of the engine are developed in the following manner (see Figure 1): The gas acting downwardly on the piston as indicated at G is resisted by the rod R and by the lateral thrust of the piston with the cylinder. Inasmuch as action and reaction are equal under these conditions, there is a force developed which tends to rotate the engine. A series of successive power strokes often results in rocking the engine violently. This is most noticeable as the frequency of the engine impulses approaches the natural period of vibration of the engine on its mounting. It occurs mostly at slow speeds on modern automobiles.

Figure 1 shows that the piston moves through the top half of the stroke while the crank moves through the points A, B, C. It moves through the bottom half of its stroke while the crank travels through B, D, A, this latter distance being considerably greater than the distance A, B, C. Since the crank travels at approximately uniform speed during the cycle, it is apparent that the accelerative forces are highest on the top half of the stroke. At high speeds they are proportionately increased, and since in a four cylinder engine two pistons on the top stroke are opposed by two on the bottom, alternately, it is evident that there are unbalanced forces which set up a considerable vibration. This vibration is largely in the direction of piston travel. However, its direction may be modified by other factors such as offset cranks, lack of balance in moving parts, etc., see Figure 13. The direction of vibration can be determined by recording instruments.

The numeral 1 designates the side rails of an automobile chassis. The numeral 2 generally designates the engine or engine base, having horizontally arranged extensions 3. In the form shown in Figures 1 and 2, the resilient supporting elements are arranged within the side rails 1, and extend generally in a direction longitudinally of engine and chassis. Two different forms of the spring are shown, both having a vertical portion 6 to which a corresponding engine extension 3 is attached. It is advantageous under certain conditions to use different forms of the spring for a given mounting, while under other conditions it is best to use springs of the same form. It will be noted that two forms of springs shown in Figure 2 differ only in that in one instance the two horizontal arms 5 extend in the same direction while in the other instance the two arms 7 (corresponding to arms 5) extend in opposite directions. Spacers 8 are used to provide clearance between the horizontal portions 5, 7, and the flanges of the rails 1. The spring elements are herein shown as attached at their terminals by means of bolts 10. Bolts 11 are used to make the attachment of the extension 3 with the vertical portions 6.

The arrangement of the arms 5, (see Figure 2) is one which permits a reduction in length of the spring element. Therefore, the arms 5 are arranged in the manner differing from the arrangement of the arms 7 to reduce the length of the spring. Both springs have substantially the same resilient action, or resilient characteristics. It will be noted that each spring provides spring elements in different planes, in this instance vertically spaced planes.

It will be further noted that there are two springs each having arms 5, one of these springs being arranged at each side of the engine. Likewise there are two pairs of springs each having elements 7, one of these springs being arranged at each side of the

engine. In the present illustration, therefore, there are four springs shown and they have, when viewed in plan, substantially the relations of the corners of a rectangle. However, such an exact geometric relation is not always necessary, and two of the springs on one side may be brought nearer together or farther apart, and the space between the springs of one side does not necessarily have to be the same as the corresponding space for the springs of the other side. In general, however, it seems best to support the engine at four points substantially as shown in Figure 7, although this figure shows the long dimensions of the springs aligned transversely of the chassis and of the engine, while in Figures 1 and 2 these springs are substantially parallel to the long dimension of the chassis and engine.

By an inspection of Figure 2, it will be seen that the engine cannot rock in any but negligible degree, because to obtain such a rocking or twisting motion, the vertically spaced elements 5, 5—7, 7, of the resilient elements would have to be flexed in edgewise or horizontal direction. However, the arrangement of the springs with relation to the engine base is such that they are relatively rigid in opposing this action, so that very little or no rocking or rotating action can take place. It will further be observed that this result is obtained no matter where the center of rotation is taken. Furthermore, the arrangement will oppose pitching of the engine as when the car is traveling on a rough road. Under the latter conditions, the action is not opposed by an edgewise flexure of the spring but by a direct endwise stress. These springs can be of various types and can be mounted differently, so that they may be arranged to meet all the various conditions encountered in this work. It is contemplated to mount single cantilever springs at different points of the support, and at different levels. This latter type of mounting need not be used at all points of support but at one or more points. If this latter form of mounting is used at all points, four, of the support for the engine, then the engine continues to serve in some degree as a chassis stiffener just as it is when it is mounted in the ordinary substantially rigid manner. Although the discussion has been centered on engines of the four cylinder type, the improved method of mounting has been successfully used on other types having a greater number of cylinders.

In Figures 3, 4, 5 and 6 there have been illustrated forms of mounting composed of straight flat springs arranged to take care of the special conditions. As shown in these figures, the springs are flat and are horizontally arranged and extend substantially in a direction perpendicular to the long axis of the engine, see Figure 7.

The spring elements are also supposed to be arranged as shown in Figure 8 and these figures are drawn in a manner to suggest this arrangement, notwithstanding the fact that each figure shows a modification. This form is used when the installation requires short length springs, in Figure 3 two superposed laminations are used, in Figure 4 a single length is shown while in Figure 5 three laminations are used. Figure 6 illustrates how the degree of resiliency can be varied by using a series of laminations of different length. In any instance, when the springs are arranged in substantially vertically superposed parallel relation, substantially as shown in Figure 8, the rotative action, or the transference of vibrations from the engine to the frame are substantially prevented. The illustration of Figures 7 and 8 correspond substantially to that shown in Figure 4, but here a single thickness short length spring element is used, and, in this instance, the springs are arranged at the outside of the side rails 1, and above and below the same, obtaining a greater vertical spacing a, which is advantageous in that the greater the vertical spacing the more efficient the device will be in preventing rotative or rocking motions of the engine.

The advantage gained in the forms of the invention shown in Figures 9 and 10 is that the vertical height a between the upper and lower elements of the springs can be increased to the desired degree over the vertical height b of the side rails of the chassis. The increase of vertical height resists to greater degree the rotative or rocking motion about any center of oscillation of the engine. By the teachings set forth herein, such rotative or rocking motion is resisted no matter where the center of oscillation of the engine may be, or no matter where the springs are placed in regard to the center of oscillation.

In carrying out the arrangement shown in Figures 9 and 10, brackets 30 are used, which are suitably attached substantially as shown. Upon these brackets the spring elements 31 and 32 are mounted. As shown in Figure 9, two brackets 30 have been used, one for each connecting element, but it is conceivable that a single bracket may be used of a length permitting both springs to be mounted thereon. The types of springs here shown are substantially similar to those shown in Figure 2, and the method of mounting is substantially the same. The only substantial difference is that the more elongated vertical portion 6 of that spring which has its arms parallel, is arranged nearer instead of farther from its companion supporting element on the same side. Plates 34, as extensions of the engine, are used in this instance to connect legs and springs.

In Figures 11 and 12 another modification has been shown in which strap-like

springs 35 are horizontally arranged in superposed parallel relation, each spring being spaced by suitable blocks, or equivalent devices, from the corresponding flanges of the side rails, and being terminally connected thereto by such means as bolts 36. The spacing blocks are used in this instance in a manner similar to that shown in the other modifications. The engine legs 38 are in this instance arranged between the spring elements 35 at a point intermediate the points of connection of the elements 35 with the frame.

The structural advantages of the form shown in Figures 11 and 12 are that a less number of bolts are necessary, and that it is easier to establish alignment in drilling than in the case where two bolts are used to terminally connect the springs, for instance, as shown in Figure 2. This possible mis-alignment of the bolt openings in longitudinal direction, would throw the springs in lateral direction so that they could not be so easily connected with the engine. The reduction in number of drill openings and of parts reduces assembly costs to a minimum. It is to be understood, however, that the springs may be connected in any suitable manner, the most important feature of the invention residing, of course, in the particular arrangement of the spring elements, whereby the usual tendency of the engine to rock upon its mounting, when laboring, will be substantially eliminated, while natural vertical motion of the engine is permitted within a limited degree.

In many cases it has been found that the major axis of the vibratory path which the engine describes, is not vertical, nor exactly parallel to the direction of piston travel, as indicated by line *e*, Figure 13. In this case it has been found desirable to incline the resilient connecting elements or springs in the manner shown by line *f*, so that their direction of greatest flexibility will more nearly coincide with the direction or path through which the engine tends to move, due to its unbalanced forces.

If a body is supported by two springs spaced apart and of such construction that they are relatively flexible toward or away from each other at point of attachment to the body, and relatively stiff in a direction at right angles thereto, it will be evident that the body may freely vibrate in a vertical direction and that rotative or horizontal movements will be minimized. Moreover, the springs may be placed so that they are not in the same horizontal plane, or in a direction transversely to the action of the engine. In the practical application of this invention to the mounting of an engine upon a chassis, it is desirable that the engine, if of the vertical type, be free for vertical movement so as not to transmit its most effective vibrations to the vehicle. Under some conditions, one spring should be placed above or in a higher plane than the others, or a special spring should have its ends offset vertically. The springs may be attached close to the side rails of the car frame with the free ends attached to the engine foot or extension.

We claim as our invention :

1. In combination, a chassis, an engine, and resilient connections between them, comprising spring elements arranged in vertically spaced substantially parallel relation.

2. In combination, a chassis, an engine, and resilient connections between them, comprising spring elements arranged in vertically spaced pairs.

3. In combination, a chassis, an engine, and resilient connections between them, comprising flat spring elements horizontally arranged in vertically spaced pairs at front and rear of and on both sides of the engine.

4. In combination, a chassis, an engine, and connections between them arranged to resist motion of the engine except in substantially a vertical direction, said connections being composed of springs vertically spaced.

5. In combination, a chassis, an engine, and connections between them arranged to resist motion of the engine except in substantially a vertical direction, said connections being composed of flat springs horizontally arranged and substantially vertically spaced in superposed relation.

6. In combination, a chassis, an engine, and connections between them arranged to resist motion of the engine except in substantially a vertical direction, said connections being composed of springs horizontally arranged in vertically spaced pairs on opposite sides of the engine.

7. In combination, a chassis, an engine, and resilient connections between them, comprising flat spring elements horizontally arranged, in vertically spaced pairs, at opposite sides of the engine.

8. In combination, a chassis, an engine, and resilient connections between them, the connections comprising flat elements having their cross-sectionally long dimension arranged at an angle to the longitudinal axis of the engine, said elements being vertically spaced.

9. In combination, a chassis, an engine, and connections between them arranged to resist motion of the engine except in substantially a vertical direction, said connections being composed of flat springs horizontally arranged and vertically spaced.

10. In combination, a chassis, an engine, and connections between them arranged to resist motion of the engine except in substantially a vertical direction, said connections being composed of flat springs arranged in vertically spaced substantially parallel relation.

11. A chassis, an engine, resilient elements securing the chassis to the engine, said ele-

ments having portions arranged in vertically spaced relation in a manner to permit their free movement with respect to the frame and each other, the portions being connected to the chassis, and the engine being connected to the resilient elements at points intermediate their points of connection with the chassis.

12. A chassis, an engine, resilient elements securing the chassis to the engine, each element having two portions arranged in vertically spaced relation in a manner to permit their free movement with respect to the frame and each other, each portion being separately connected to the chassis, and the engine being connected to each element at a point intermediate the connecting points of said portions with the chassis.

13. A chassis, an engine, flat springs securing the chassis to the engine, each spring having portions arranged in vertically spaced relation in a manner to permit their free movement with respect to the frame and each other, the portions being separately connected to the chassis, and the engine being connected to each spring at a point intermediate the points of connection of the spaced portions with the chassis.

14. A chassis, an engine, resilient elements securing the chassis to the engine, each element having portions arranged in vertically spaced relation in a manner to permit their free movement with respect to the frame and each other, the portions being separately connected to the chassis, and the engine being connected to each element at a point intermediate the points of connection of the spaced portions with the chassis, the attaching points of the portions of the springs being aligned in a direction making a slight angle with the vertical plane.

15. A chassis, an engine, resilient elements securing the chassis to the engine, each element having portions arranged in vertically spaced relation in a manner to permit their free movement with respect to the frame and each other, the portions being separately connected to the chassis and the engine being connected to each element at a point intermediate the points of connection of the spaced portions with the chassis, the attaching points of the portions of the springs being aligned in a direction making a slight angle with the vertical plane, and said portions extending in a direction substantially parallel with the longitudinal axis of the engine base.

In witness whereof, we have hereunto set our hands this 29th day of July, 1927.

ROBERT SARDESON.
FRANK J. LA MERE.
JOHN CORSER.