Dec. 8, 1936. R. S. TROTT ET AL 2,063,064

EYED AXIS-LOCATING ENGINE UNIT MOUNTING

Filed Nov. 18, 1933 4 Sheets-Sheet 1

FIG. 1

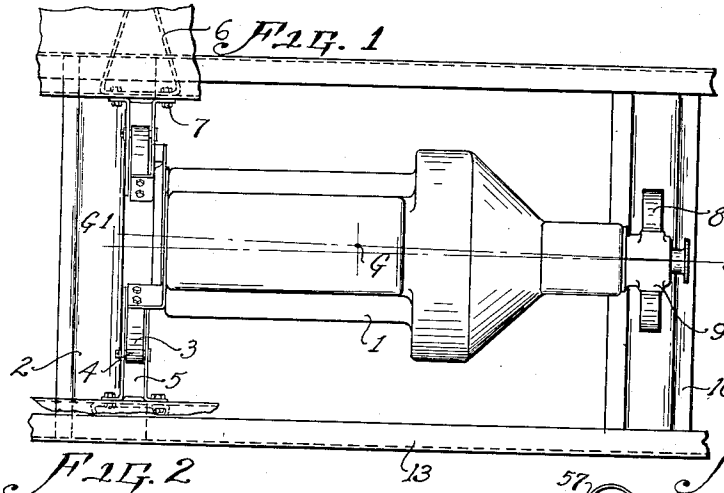


FIG. 11

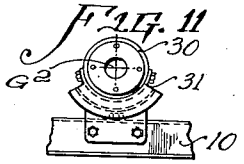


FIG. 12

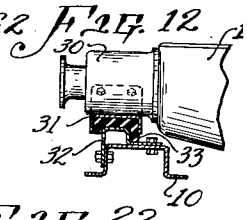


FIG. 2

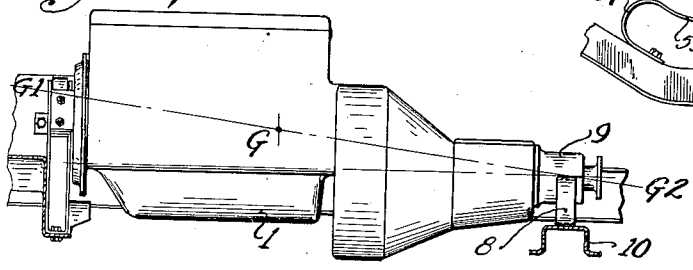


FIG. 22

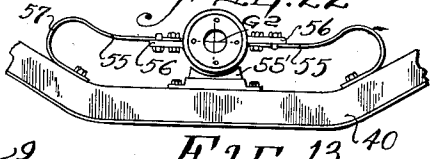


FIG. 13

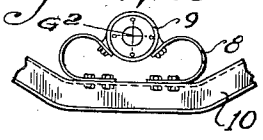


FIG. 3

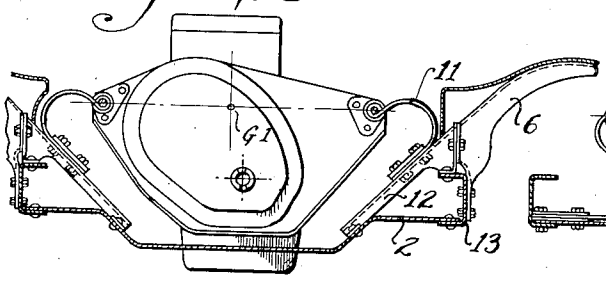


FIG. 5

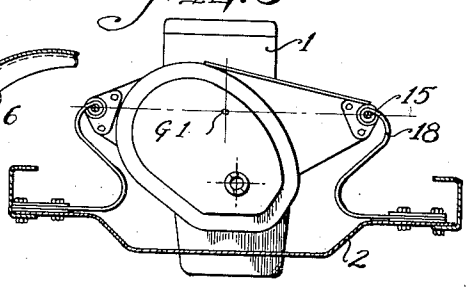


FIG. 4

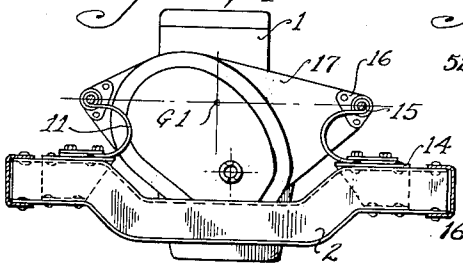


FIG. 20

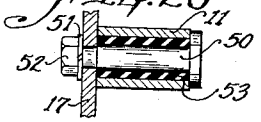


FIG. 3A

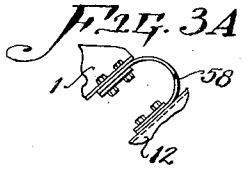
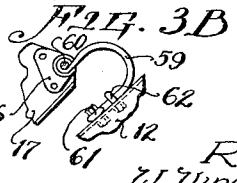


FIG. 3B

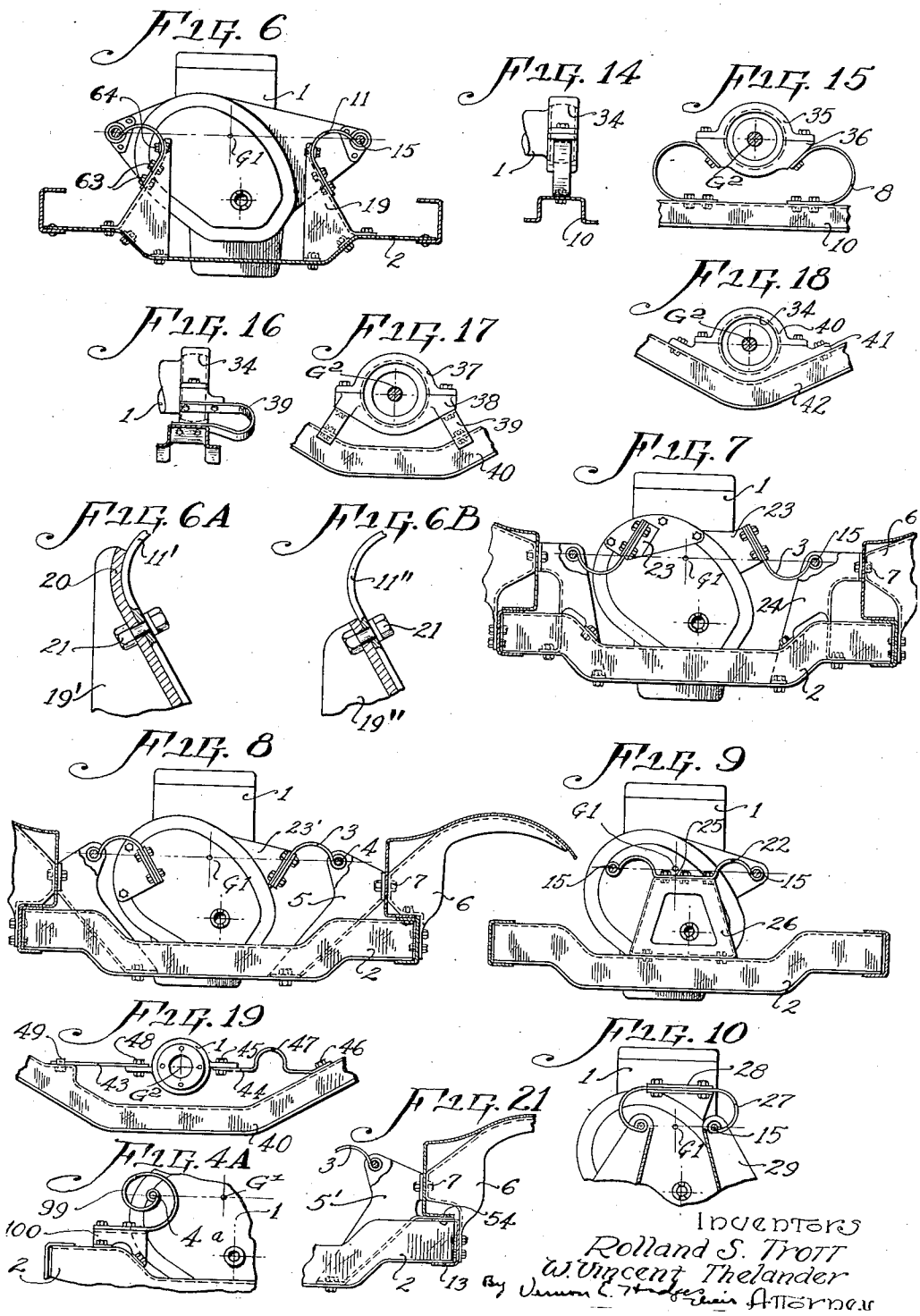


Inventors
Rolland S. Trott
W. Vincent Thelander
By Vernon E. Hodgeslein Attorney

Dec. 8, 1936. R. S. TROTT ET AL 2,063,064

EYED AXIS-LOCATING ENGINE UNIT MOUNTING

Filed Nov. 18, 1933 4 Sheets-Sheet 2



Inventors
Rolland S. Trott
W. Vincent Thelander
By Vernon L. Hodges Their Attorney

Dec. 8, 1936. R. S. TROTT ET AL 2,063,064

EYED AXIS-LOCATING ENGINE UNIT MOUNTING

Filed Nov. 18, 1933 4 Sheets-Sheet 3

FIG. 23

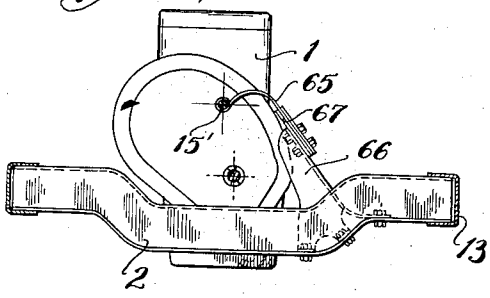


FIG. 24

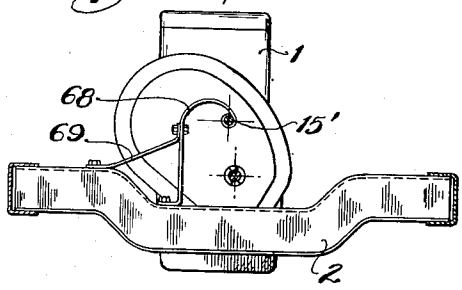


FIG. 25

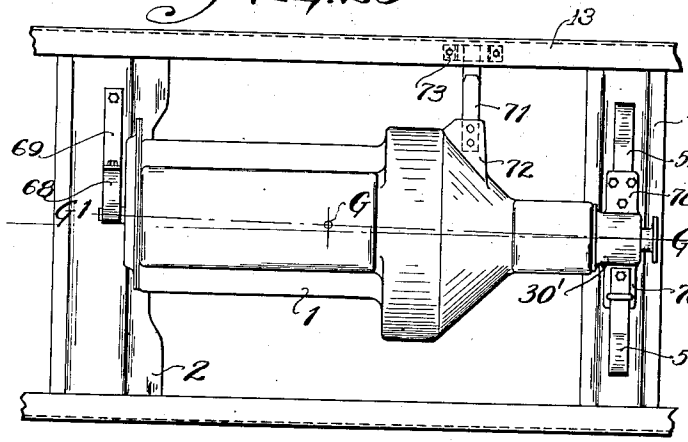


FIG. 27

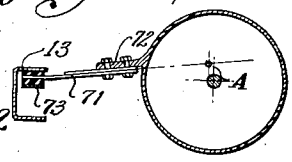


FIG. 26

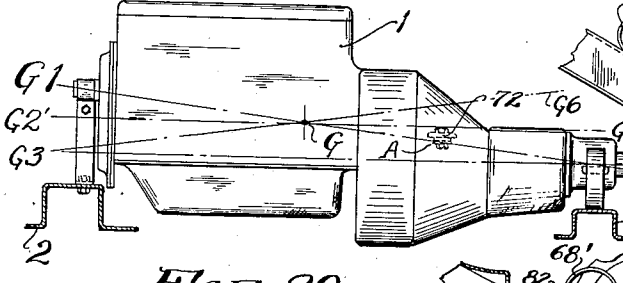


FIG. 28

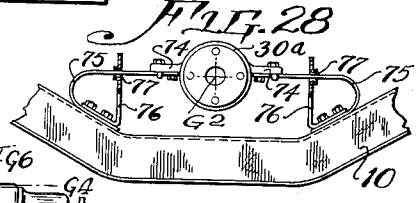


FIG. 29

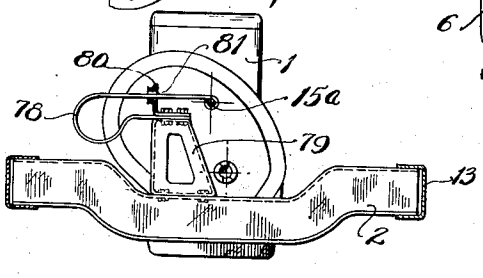
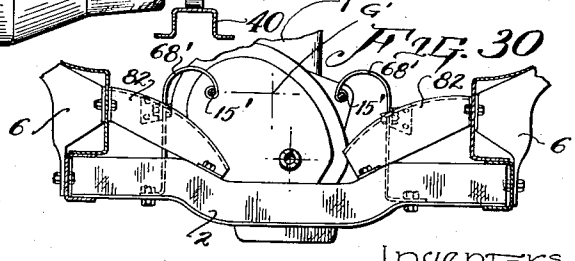


FIG. 30



Inventors
Rolland S. Trott
W. Vincent Thelander
By Vernon E. Hoobler
Their Attorney

Dec. 8, 1936. R. S. TROTT ET AL 2,063,064

EYED AXIS-LOCATING ENGINE UNIT MOUNTING

Filed Nov. 18, 1933 4 Sheets-Sheet 4

FIG. 31

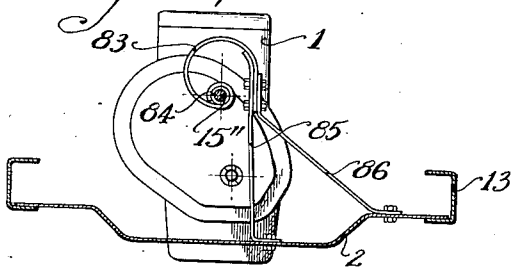


FIG. 32

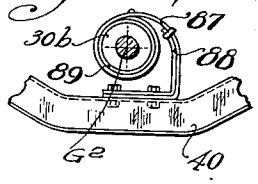


FIG. 36

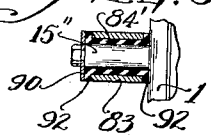


FIG. 33

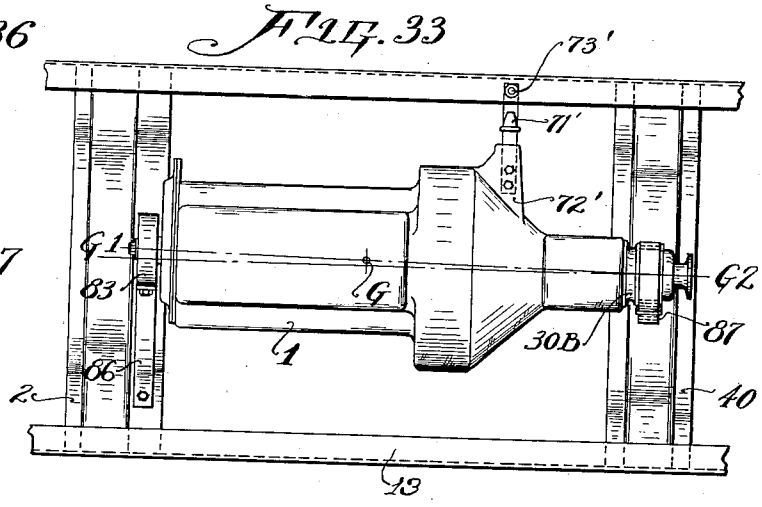


FIG. 37

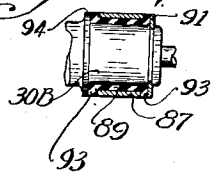


FIG. 34

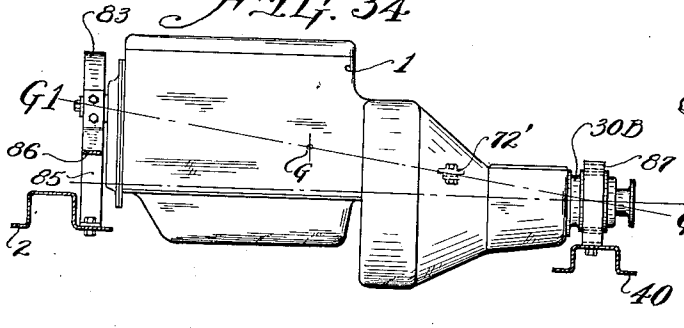


FIG. 32A

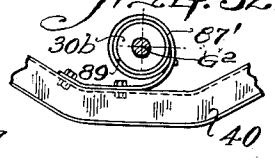


FIG. 35A

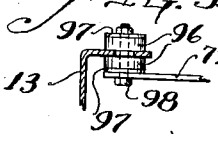


FIG. 35

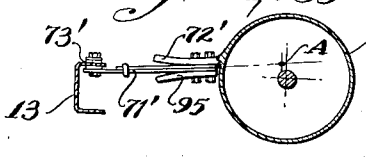
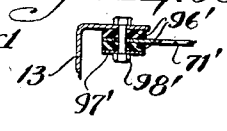


FIG. 35B



Inventors
Rolland S. Trott
W. Vincent Thelander
By Vernon E. Hodges
their Attorney

Patented Dec. 8, 1936 2,063,064

UNITED STATES PATENT OFFICE

2,063,064

EYED AXIS-LOCATING ENGINE UNIT MOUNTING

Rolland S. Trott, Denver, Colo., and Wilbur Vincent Thelander, Rockford, Ill.; said Thelander assignor to said Trott

Application November 18, 1933, Serial No. 698,720

11 Claims. (Cl. 248—7)

This invention has to do with engine unit mountings by which engine units may be mounted upon their supports or frames, and more especially to metallic engine unit mountings adapted to provide resiliently opposed transverse movement in any direction combined with torque cushioning oscillation about a longitudinal axis passing substantially through the center of gravity of the engine unit and intersecting the crankshaft of the engine unit adjacent one of the mounting structures.

More specifically this invention shall be known as the "eyed, axis-locating engine unit mounting", wherein both the front and rear mountings are so positioned and the opposition to the engine forces is such, as to definitely determine the axis of oscillation as passing directly through the centers of both points of the mounting. The front mounting, as will be seen in the figures hereinafter described, has the springs so located as to be diametrically opposite one another, and a line drawn through the eyes or attaching portions will intersect the axis of oscillation whether the springs be at the same level or not and the eyed portion may be attached either to the engine unit or to the supporting member.

If so desired, the springs may be clamped at both ends, as more specifically set forth in our co-pending and supplementary application which is known as the "Clamped, axis-locating engine unit mounting", Serial No. 698,721, filed November 18, 1933; and in either case whether the springs are attached by means of the eye or by the clamping method, the oscillatory movement provided by the springs will be at the level of the axis of oscillation of the engine unit. In all cases shown, the eyes, or attaching portions locate the axis, but it may be desirable in some cases to so position the eyes, or attaching portions, as to have one below the axis level and one above the axis level, but still diametrically opposed with respect to the axis at that point.

This application was executed and filed at the same time and in conjunction with our co-pending application, which is entitled the "Clamped, axis-locating engine mounting", Serial No. 698,721, filed November 18, 1933, its variation being in the use of one eyed portion and one clamped portion rather than having both ends clamped as in the other case.

The eye positions of the springs are substantially at the level of the axis of oscillation of the engine unit, and the eyed portions may be mounted upon either the engine unit or the frame or supporting member.

By means of the front mounting construction as set forth in this invention, we are able by the proper placing of the eyes substantially at the level of the axis of oscillation and diametrically opposite each other at the front of the engine unit, to very closely locate the pivote point and thereby prevent appreciable lateral mass displacement.

By experiment we have found that the front mounting, as set forth in this invention, may or may not resiliently oppose the torque forces incident to the operation of the power plant and that the rear mounting may be of various types of construction and may assist the front mounting in opposing a part of the torque forces, or may be of a type which does not assist the front mounting in opposing torque forces. And in case neither mounting acts to sufficiently oppose the torque forces, we have found that additional torque opposing means may be satisfactorily used.

The object of this invention is to provide a metallic engine mounting structure which will, under any and all conditions, quite closely though resiliently preserve the position of the higher end of the axis of oscillation while also acting to provide resiliently opposed oscillation of the engine unit about said axis.

A further object is to provide a metallic engine mounting structure which will under any and all conditions quite closely though resiliently preserve the position of the lower end of the axis of oscillation while permitting torque cushioning oscillation of the engine unit about said axis.

A further object is to provide both front and rear metallic mountings, either of which will cooperate with a non-metallic mounting structure to provide a satisfactory mounting for an engine unit which will properly cushion transverse and torque forces incident to its operation.

A further object is to provide a metallic front mounting in which the resilient resistance to horizontal transverse movement may be sufficiently increased to properly maintain the position of that end of the axis of oscillation even under the most extreme torque conditions at low engine speed while still maintaining sufficiently resilient vertical movement.

A further object is to provide a metallic rear mounting in which the resilient resistance to horizontal transverse movement may be sufficiently increased to properly maintain the position of the axis of oscillation even under the most extreme torque conditions at low engine speed while still maintaining sufficiently resilient vertical movement.

A further object is to provide a complete mounting for an engine unit wherein the resilient resistance to horizontal transverse movement at both the front and the rear thereof may be so increased as to prevent substantial mass displacement even under extreme high torque at low speed, while at the same time providing proper torque cushioning oscillation, combined with the

proper slight amount of cushioning movements in any transverse direction.

A further object is to provide a complete mounting for an engine unit to be constructed of metal or non-deteriorating materials which will be of low production cost and will facilitate ease of original assembly as well as disassembly for servicing.

We accomplish the above objects by providing an eyed, axis-locating mounting in which a leaf or round wire spring is constructed with the eyed portion attached to either the engine unit or the frame, and arranged to support weight and at the same time provide horizontal as well as vertical movements along with the movements necessary for the torque cushioning oscillation of the engine unit, and in which the position of the eyes of the springs are employed to locate the axis of oscillation.

The same general objects are accomplished to a different degree in our co-pending clamped axis-locating mounting application, referred to above, which is supplementary to this application.

All of the above is more fully described in detail hereinafter and is fully illustrated in the drawings, in which:—

Fig. 1 is a plan view of an engine unit mounted by our eyed, axis-locating construction upon its frame, the eyed portions of the mounting springs being substantially at the desired level of the axis of oscillation at the front of the engine unit, and the rear mounting so disposed as to locate the axis of oscillation adjacent the rear of the engine unit.

Fig. 2 is a side view of Figure 1.

Figs. 3–10 inclusive, and Figs. 21, 23, 24, 29 and 30, show variations of our eyed axis-locating construction adapted to the front mounting.

Figs. 11–19, 22 and 28 show variations of the rear mounting construction to be used in conjunction with the front mounting constructions as set forth in this or our co-pending invention above referred to.

Fig. 20 is a fragmentary sectional view through the eyed portion of one form of construction of an eyed mounting spring.

Fig. 25 is a plan view of a rear mounting construction as shown in Figure 22, a front mounting construction as shown in Figure 24, and with the addition of a torque spring.

Fig. 26 is a side view of Figure 25.

Fig. 27 is a section taken through the bell housing of the engine unit at the location of the torque spring mounting of Figure 25.

Fig. 31 shows another form of front mounting.

Fig. 32 shows another form of rear mounting construction.

Fig. 32A shows still another form of rear mounting construction.

Fig. 33 is a plan view of an engine unit mounting showing the constructions illustrated in Figures 31 and 32.

Fig. 34 is a side view of Figure 33.

Fig. 35 is a section taken through the bell housing, showing a modified form of torque spring mounting.

Fig. 36 is a section through the pivot stud of the front mounting as shown in Figure 31.

Fig. 37 is a section through the eye of the spring used in the rear mounting construction as shown in Figure 32.

The construction of these various figures will now be described more in detail as follows:—

In Figure 1, a front view of which is shown in Figure 8, the engine unit **1** is supported upon the front frame member **2** by means of the eyed C-springs **3**, which are attached properly to the engine unit and have the eyed portions **4** supported in the brackets **5** which rest upon the front frame member **2**. The formed brackets **5** are also properly attached to the fender supports **6** by means of bolts, rivets or in any other proper manner as at **7**, the brackets **5** and **6** combining to support the fender and the front of the engine unit and being properly attached to the frame of the vehicle. It will be noted that the spring eyes **4** are at the level of the desired front end G—**1** of the axis of oscillation, and are carried by the frame.

The rear of the engine unit **1** is supported by the C-springs **8**, which are bolted or otherwise properly attached to the rearwardly projecting portion **9** of the engine unit **1**, and rest in turn upon the rear frame member **10**, and are bolted or otherwise properly attached thereto. An end view of this rear mounting construction is shown in Figure 13.

Figure 2 is a side view of Figure 1 and shows the axis of oscillation, G**1**—G**2**, located at the front mounting, as at G**1**, and at the rear mounting, as at G**2**, both mountings so located that the axis of oscillation will intersect the center of gravity of the engine unit **1**.

Figure 3 shows one form of front mounting construction wherein the eyed C-springs **11** are properly clamped to the brackets **12**, which in turn rest upon and are attached to the front frame member **2** and the frame side rails **13**, and project outwardly so as to be properly attached to the fender braces **6**; or the brackets **12** and **6** may even be made in one piece, if desired.

The eyes of the springs **11** are carried by the engine unit **1** instead of by the frame as in the Figure 1 and Figure 8 constructions. The eyes of the springs **11** are, however, at the level of the front end G—**1** of the axis of oscillation.

Figure 3A shows another form of mounting spring **58** of the C-spring type, but with both ends clamped rather than with the eyed construction for one end as shown in Figure 3. The spring **58** is bolted or otherwise properly attached to the engine unit **1** and to the bracket **12** and rests at the same angle with respect to the crankshaft as the spring **11** of Figure 3. This type of spring, rigidly clamped at both ends, may be substituted in any case or construction for the eyed C-springs as shown and set forth as a part of this invention, but it will not so definitely locate the point G—**1** as does the eyed construction.

Figure 3B shows another form of eyed C-spring for the front mounting similar to the springs **11** of Figure 3 but constructed of round wire rather than flat spring steel as shown in Figure 3.

The spring **59** has the eyed end **60** flattened and curled to form the eye, which receives the stud held in place by the bracket **16** of the timing gear cover back plate **17**, which is properly attached to the engine unit **1**.

The other end **61** of the spring **59** is curled and turned 90° to the eye **60**, and a bolt is inserted in the eye **61** to clamp the spring **59** to the bracket **12**. The U-clamp **62** serves to further properly attach the spring **59** to the supporting bracket **12**. This type of round wire eyed C-spring may, if desired, be substituted in any case wherein the flat steel eyed C-spring is shown and mentioned in this invention.

Figure 4 shows another front mounting construction wherein the eyed C-springs **11** have

their clamping portions in the horizontal plane, and supported by and attached to the brackets 14. The brackets 14 rest upon and are attached to the front frame member 2. The eyed portions 15 receive the mounting studs which are properly secured to the brackets 16. The brackets 16 are attached to the timing gear cover back plate 17, which is properly attached to the engine unit 1.

Figure 4A shows a construction that is somewhat similar to that shown in Figure 4 but wherein the front of the engine unit 1 is mounted upon the one and one-quarter wrap mounting springs 99, which are pivotally attached as at 4a to the engine unit at the level of the axis of oscillation. The mounting springs 99 rest upon and are properly secured to the support brackets 100 which are bolted or otherwise properly attached to the front frame member 2.

Figure 5 shows another form of front mounting construction wherein the eyed C-springs 18 have a reverse loop and are attached directly to the front frame member 2, and the studs for mounting the eyed portions 15 are properly attached to the engine unit 1 at the level of the axis of oscillation.

Figure 6 shows another form of front mounting construction wherein the eyed C-springs 11 are rigidly attached to the brackets 19 by the two bolts 63 and the clamp and bolts as shown at 64, the brackets 19 being properly attached to the front frame member 2. The eyed portions 15 are pivotally mounted on studs which are properly secured to the engine unit 1. The brackets 19 and clamps and bolts 64 may be extended along the curve of the springs 11 to reduce the transverse horizontal movement as desired.

Figure 6A is a fragmentary view showing part of the attaching and supporting portion of the bracket 19' and the eyed C-spring 11'. The bracket 19' is similar to the bracket 19 in Figure 6, the only variation being in the elimination of the clamp and bolts as shown at 64 of Figure 6. The arcuate portion 20 of the bracket 19' is formed to be concentric with and fit the loop of the spring 11'. It will be seen from Figure 6A that under the action of the transverse forces in one direction only, the spring 11 will be allowed to move away from the portion 20 of the bracket 19', so that but one spring at a time acts to resiliently oppose transverse horizontal movement and therefore this construction is more flexible horizontally than the Figure 6 construction.

Figure 6B shows a portion of the spring 11'' and a portion of the bracket 19'' wherein the curved portion of the spring 11'' has no arcuate supporting portion similar to the portion 20 of Figure 6A. The spring 11'' is properly attached to the bracket 19'' by the bolt 21, or in any other proper manner. It can be readily seen that this construction minus the arcuate supporting portion 20 of the bracket 19' will offer less support to the spring 11' and result in less resilient resistance to the action of the horizontal transverse forces of the engine unit. By using any of the forms as shown in Figures 6, 6A and 6B for supporting the springs 11, 11' and 11'' or any other further variations thereof with any one form of eyed C-spring, we can obtain any number of transverse proportions in relation to a given vertical opposition to the action of the engine forces. Figure 6 shows an extreme condition for transverse rigidity, and Figure 6B shows the condition where the unsupported curve of the spring 11'' serves to very resiliently oppose the transverse forces. By variation of the length of the arcuate portion 20 of the bracket 19' and by variation of the position of the bolt and clamp 64, we can secure any desired resistance between these two.

Figure 7 shows another form of front mounting construction wherein the eyed C-springs 3 have their clamped portions properly secured to the seats 23 provided on the engine unit 1, and the eyed portions 15 of the springs 3 receive the studs held in the brackets 24. The brackets 24 rest upon and are secured to the front frame member 2 and are properly secured to the fender brace 6 as at 7 and act as a supporting member thereto. The eyes of the springs 3 are on the level of the axis of oscillation as at G—1.

Figure 8 shows a front mounting construction wherein the eyed C-springs 3 are properly attached to the spring seats 23' provided on the engine unit 1, and the eyed portions 4 are received by the studs carried by the brackets 5. The brackets 5 rest upon the front frame member 2 and are rigidly attached to the fender braces 6 by means of the bolts 7 or in any other proper manner, and act as supports therefor. The eyes of the springs 3 are on the level of the axis of oscillation as at G—1 and therefore above the crankshaft of the engine unit.

Figure 9 shows another form of front mounting construction wherein the double-ended eyed C-spring 22 has a flat portion 25 which rests upon and is secured to a pedestal 26 which in turn rests upon and is secured to the front frame member 2. The eyed portions 15 pivotally receive studs which are carried by the engine unit 1 and which are on a level with the point G—1 in the axis of oscillation.

Figure 10 shows another form of front mounting construction wherein the double-ended eyed C-spring 27 is properly attached to the seat 28 provided on the engine unit 1, and the eyed portions 15 are pivotally mounted on pins carried by the brackets 29, which rest upon and are secured to the frame or supporting member.

Figures 11 and 12 show a rear mounting construction wherein a rearwardly projecting portion 30 of the engine unit 1 is so formed as to receive the member 31, which is properly secured to it. A formed portion 32 is properly attached to the rear frame member 10. The rubber portion 33 is bonded or otherwise properly secured to the portions 31 and 32, and thereby serves to resiliently oppose the movements of the engine unit which at this point are in general about the crankshaft axis as a center.

Figure 13 is a rear view of the rear mounting construction as shown in the plan view in Figure 1. The rearwardly projecting portion 9 rests upon and is secured to the C-springs 8, which in turn rest upon and are properly secured to the rear frame member 10. The springs 8 for oscillations of quite small amplitude locate the axis of oscillation quite closely at the crankshaft axis, though this does not hold true for oscillations of large amplitude.

Figures 14 and 15 show a rear mounting construction wherein the engine unit 1 has a rearwardly projecting portion 34 which is of a spherical form and is received in the split bracket portions 35 and 36. The portion 36 rests upon and is properly attached to the C-springs 8, which in turn rest upon and are properly attached to the rear frame member 10.

In this construction, the rear of the engine unit is permitted to move freely about its axis

of oscillation at this point and the springs 8 offer no resistance to the torque forces, but provide resiliently opposed movement in any transverse direction. The spherical portion 34 being received in the split bracket portions 35 and 36 tends to resiliently restrict the endwise movement of the power plant with respect to the frame, but locates the axis of oscillation at the crankshaft axis at this point.

Figures 16 and 17 show another form of rear mounting construction wherein the engine unit 1 has a rearwardly projecting spherical portion 34 received in the split bearing portions 37 and 38. The portion 38 rests upon the parallel-ended C-springs 39, which are parallel to the center line of the crankshaft and rest upon and are properly secured to the angular portions of the rear frame member 40. This construction also locates the rear of the axis of oscillation at the crankshaft.

Figure 18 shows another form of rear mounting construction wherein the rearwardly projecting spherical portion 34 of the engine unit 1 is received in the split bearing portions 40 and 41. The lower split bearing portion 41 is attached directly to the rear frame member 42 and the resulting action of this form of construction at the rear mounting is wholly pivotal without any opposition to the torque forces and without any resilience in the opposition to the other forces at the rear of the engine unit and incident to the operation of the engine unit.

Figure 19 shows another form of rear mounting construction wherein the rear of the engine unit 1 rests upon the leaf springs 43 and 44. The spring 44 is properly attached to the engine unit 1, as at 45, and to the rear frame member 40, as at 46, and provides resilient opposition to transverse forces at the rear of the engine unit by means of the curved portion 47. The spring 43 is properly attached to the rear of the engine unit 1, as at 48, and the opposite end of the spring is slidably secured to the rear frame member 40 by means of a U-bolt construction, as shown at 49. Both springs act to provide resiliently opposed, vertical movement and both act to resiliently oppose torque cushioning oscillation of the engine unit and act to quite closely locate one end of said axis approximately at the crankshaft axis. This type of construction is also adaptable to the front mounting construction, in any case the axis of oscillation being located substantially at the level of and intermediate the two springs.

Figure 20 is an enlarged section taken through the eye of a C-spring wherein the C-spring 11 is properely held in place by the shouldered stud 50, which is properly attached to the timing gear cover back plate 17 by means of the lock washer 51 and nut 52. A bushing 53 is received in the eye of the spring 11 and serves to either resiliently cushion horizontal and vertical forces or give a freedom of pivotal motion about the stud 50 dependent upon the type of material used for the bushing 53. The portion 53 may be of bronze or other proper material to permit the ease of pivotal motion, or it may be made of rubber, as indicated in the drawings, or of any other proper resilient material to permit a slight amount of resiliently opposed transverse, as well as pivotal, movement between the stud 50 and the spring 11 at this point.

Figure 21 shows another form of front mounting construction very similar to that set forth in Figure 8, the variation being in the form of and in the method of attaching the bracket 5' to the front frame member 2 and the side rail 13.

The bracket 5' is shown to be rigidly attached by means of rivets or in any other proper manner to the frame side rail 13, as at 54, and is rigidly bolted or otherwise properly attached to the fender brace 6, as at 7. The eyed C-spring 3 is attached to the engine unit 1 and to the bracket 5' in a manner similar to the construction shown in Figure 8.

The variation as set forth in this construction resides in two separated attachments for the bracket 5' to the frame and thus the bracket 5' is independently supported and acts as a very rigid fender support and permits the assembly or disassembly of the fenders of the vehicle without in any way affecting the motor mounting construction.

Figure 22 shows another form of rear mounting construction wherein the rear of the engine unit 1 has the pads or seats 56 projecting outwardly therefrom with the springs 55 bolted or otherwise properly attached thereto, and which have the C-ends 57 so disposed that the attaching portion properly fits the form of the rear frame member 40. The springs 55 are so placed as to be substantially on the level of the crankshaft axis and of the axis of oscillation.

This construction provides resiliently opposed, horizontal and vertical transverse movements and also resilient opposition to torque cushioning oscillation about an axis whose adjacent end is quite closely located. The normally inactive rubber bumper 55' limits the downward movement.

Figure 23 shows a form of front mounting construction wherein the engine unit 1 has a supporting trunnion received in the eye 15' of the mounting spring 65 which is properly attached to and supported by the bracket 66. The bracket 66 in turn rests upon and is properly attached to the front frame member 2. The spring 65 has the supporting leaf 67, which strengthens and stiffens the spring 65. The length, strength and number of supporting leaves employed will depend upon the conditions of each case.

Figure 24 shows a front mounting construction wherein the engine unit 1 has a supporting trunnion properly received in the eye 15' of the mounting spring 68. The mounting spring 68 rests directly upon and is properly attached to the front frame member 2. The spring 68 has a supporting strut 69 which is properly attached to the spring and to the front frame member 2 and acts as a stabilizing member or brace therebetween and tends to restrict the resiliently opposed transverse movement of the eye 15' of the mounting spring 68 in a greater or lesser degree dependent upon the height at which said strut is attached to the spring. The eye 15', of course, locates the front end of the axis of oscillation.

Figure 25 is a plan view wherein the engine unit 1 is mounted upon a rear mounting construction as shown in Figure 22, with a front mounting construction as shown in Figure 24, and with the addition of a torque spring 71, as further illustrated in Figure 27.

The front of the engine unit 1 is pivotally supported upon the spring 68, which is properly attached to the front frame member 2.

The spring 68 is supported by the strut or brace 69 properly attached to the spring 68 and to the front frame member 2. This brace 69 gives transverse horizontal stability to the spring 68. The rear of the engine unit 1 has the spring seats 70 integral with the rearwardly projecting portion 30' to which the springs 55 are properly at-

tached and which springs 55 rest upon the rear frame member 40 and are properly attached thereto.

The torque spring 71 is attached to the pad 72 provided on the engine unit 1 and the outer end of the torque spring is received by the metal and rubber bracket 73 or in any other proper manner in such a way as to resiliently oppose the torque cushioning movements of the engine unit.

The front and rear mountings as shown in this construction are so disposed as to cause the line G1—G2, drawn through the centers of action of the respective mountings, to pass substantially through the center of gravity G of the engine unit.

Figure 26 is a side view of the mounting construction shown in Figure 25 and serves to show more clearly the position of the torque spring 71 if extended into this plane as at A. A line G1—G2, drawn through the centers of action of the front and rear mountings, passes substantially through the center of gravity G as well as the point A at which the torque spring 71, if extended would intersect the line G1—G2.

The axis of oscillation may be made parallel to the crankshaft, as G2'—G4, or the axis may be made to slant downward toward the front, as G3—G6. Both of these changes in the location of the axis of oscillation may be made by changing to front and rear mountings of the proper heights, while still maintaining the axis substantially through the center of gravity G.

Figure 27 is a partial transverse section taken through the bell housing of the engine unit 1 and showing the mounting of the torque spring 71. The point A denotes the location on the axis of oscillation of the point from which the torque spring, if extended, would project radially. The spring 71 is properly attached to the pad 72 of the engine unit 1 and is also received in the rubber and metal bracket 73, which is properly attached to the frame side rail 13. This method of mounting the torque spring radially with respect to the axis of oscillation tends to resiliently oppose the torque forces of the engine unit with the least possible introduction of forces of a transverse, horizontal or vertical nature, or of a combination of such forces.

Figure 28 shows a rear mounting construction wherein the rearwardly projecting portion 30a of the engine unit 1 has provided thereon the pads 74 to which the springs 75 are properly attached and which springs rest upon and are properly attached to the rear frame member 10. The restricting brackets 76 are attached to the rear frame member 10 at the same points as the springs 75 and rest thereupon. The brackets 76 have openings 77 provided therein to permit the normal movements of the springs 75. These openings and brackets serve to restrict and oppose excessive vertical movement at this point of the motor mounting after a small predetermined free movement. It can readily be seen that under normal movements the rate of the springs 75 in opposition to the forces causing said normal movements will be considerably lower than the rate of the spring in opposing excessive movement after it has come in contact with the brackets at the openings 77 of the restricting brackets 76, and by virtue of this dual effect we have named this type of construction the "double quantity spring".

This construction is identical with one shown and described in our supplementary and co-pending application known as the "Clamped axis-locating engine unit mounting".

It will be seen that the springs 75 are greatly stiffened against vertical movement when they contact the brackets 76 but still provide a spring mounting. Also the only stiffening of the action of the springs 75 in a transverse horizontal direction is due to frictional engagement with the brackets 76.

Figure 29 shows a double quantity spring mounting adapted to the front of the engine unit. The engine unit 1 has a mounting stud which is properly received by the eye 15a of the mounting spring 78, which rests upon and is properly attached to the supporting bracket 79. The bracket 79 in turn rests upon and is properly attached to the front frame member 2. The restricting bracket 80 co-operates with the spring 78 and with the spring 78 is properly attached to the supporting bracket 79. An opening 81 is provided in the bracket 80, through which the spring 78 passes so as to normally permit the entire spring to resiliently oppose the normal vertical movements of the engine unit at this point. Any movement of the engine unit beyond such normal limits is more rigidly opposed when the horizontal portion of the spring 78 comes into contact with the restricting bracket 80 and serves to resiliently yet firmly limit the movement of the engine unit at this point.

It will be noted that normally there is no restriction upon the transverse, horizontal movement of the engine unit as provided by the loop of the spring 78, but when the spring contacts the bracket 80 the friction of this contact also acts to resist transverse, horizontal movement.

Figure 30 shows a front mounting construction wherein the engine unit 1 has mounting studs at the height of the axis of oscillation properly received in the eyes 15' of the mounting springs 68', which rest directly upon and are properly attached to the front frame member 2 and are also properly attached to the mounting springs 68' and to the fender braces 6 in such a manner as to restrict the transverse horizontal movements of the springs 68' by shortening the free spring length and as to act as a very rigid fender brace. The bracket 82 is so designed as to permit ease of assembly and disassembly of the engine unit and the frame as well as the fenders and the frame.

Figure 31 shows a front mounting construction wherein a single eyed C-spring 83 is used with the eyed portion on the level of the axis of oscillation and carried by a mounting stud at the front of the engine unit. The spring 83 has its attaching portion rigidly secured between the support 85 and the brace 86, which parts in turn rest upon and are properly secured to the front frame member 2. The mounting stud 15'' on the engine unit is properly received in the eye of the spring 83 and the bushing 84, which is of rubber or any other proper material, serves to provide the desired freedom of pivotal motion and permits a slight amount of transverse movement in all directions in addition to that provided by the three-quarters wrap of the spring 83.

Figure 32 shows a rear mounting construction wherein the rearwardly projecting portion 30b of the engine unit is received in the large eye of the C-spring 87, which is provided with the bushing 89, made of rubber or any other proper material so as to provide the desired freedom of pivotal motion at this point of the mounting structure, as well as a slight additional amount of

transverse movement in all directions. The rubber bushing 89 offers resilient resistance to a slight amount of transverse movement in all directions in addition to that provided by the spring 87. The spring 87 has the supporting or assisting portion 88 which rests adjacent to it and is rigidly secured to the rear frame member 40 along with it. This supporting portion 88 tends to assist the spring 87 in resisting the transverse, horizontal forces at this point of the mounting structure and in some cases it may be found that its use is wholly unnecessary. The form of the spring 87 may be varied as in Figure 32A, if desired.

Figure 32A shows a rear mounting construction similar to that described and illustrated in Figure 32, and designed with the purpose in mind of obtaining a shorter free spring length and therefore a more rigid rear mounting. The rearwardly projecting portion 30b of the engine unit is received by the bushing 89 which is made of rubber or any other proper material and rests in the large eye of the spring 87', which in turn rests upon and is properly secured to the rear frame member 40. The spring 87' is of such form and design that its resilient resistance to transverse forces at the rear of the engine unit is greater than that provided by the spring designated as 87 in Figure 32, and the use of a supporting leaf designated as 88 in Figure 32 is apparently unnecessary with this shorter free length type of spring.

Figure 33 is a plan view showing the engine unit 1 properly supported on its frame 13 by means of a front mounting construction, such as shown in Figure 31, a rear mounting construction, such as shown in Figure 32, and with the addition of a torque spring construction, such as shown in Figure 35. The axis of oscillation of the engine unit is shown as a line G1—G2, which intersects the centers of action of the front and rear mountings and the center of gravity designated as G. Different heights for the front mounting may be employed as desired to vary the slant of the axis of oscillation.

Figure 34 is a side view of an engine unit mounting showing the constructions illustrated in Figure 33. The axis of oscillation is shown as the line G1—G2 and passes through the centers of the front and rear mountings and intersects the center of gravity as shown at G. The torque spring mounting is shown as at 72' and is located on the line G1—G2 in this plane.

If the position of the rear mounting remains the same, variation of the height of the front mounting may cause the axis of oscillation to pass above or below the center of gravity G.

Figure 35 is a section taken through the bell housing of the engine unit at the location of the torque spring mounting. The torque spring 71' is properly attached to the engine unit on the pad 72' and is so positioned as to project radially from the axis of oscillation to its point of attachment to the frame as shown at 73'.

The point A designates the position of the axis of oscillation at the location where this section was taken. The connection 73' of the torque spring to the frame side rail is such that it will resiliently oppose movement of the torque spring end in all directions and is shown on a larger scale in Figure 35A.

The portion 72' on the bell housing is so formed that under action of the torque forces a rolling action takes place and the bottom of the pad 72' rolls into contact with the torque spring 71', thus making the spring 71' progressively shorter and hence stiffer. Another member 95 is bolted in place at the bottom of the spring 71' to give this same rolling contact action and effect upon rebound or oscillation of the engine unit in the opposite direction resulting from the torque forces.

Figure 35A is an enlarged fragmentary view of the mounting of the torque spring end resiliently to the frame side rail 13.

The end of the torque spring 71' has secured therein the bolt 98 which passes through the two rubber members 96 one of which is above the flange of the frame side-rail and the other below and both of which are properly held in place on the bolt by the slightly cupped washers 97 and the nut. The flange of the frame side-rail 13 is provided with an opening of sufficient size and clearances so as to permit the bolt 98 to pass through it and so that at no time even under action of the torque forces will it contact the bolt with the frame. The upper rubber member 96 resiliently cushions the action of the torque forces and the lower rubber resiliently opposes the rebound therefrom.

Figure 35B shows another form of resilient connection of the torque spring end to the frame side-rail, wherein the bolt 98' is properly secured in the flange of the side-rail 13 and projects downwardly and receives thereon the two rubber members 96' one above and one below the torque spring end 71'. The washer 97' and the nut on the bolt 98' act to hold these parts assembled. The torque spring end 71' acts between the two rubber members and a hole of sufficient size for clearances is provided therein so that the bolt 98' which passes through it will at no time under any conditions contact it. Any other proper resilient torque spring mounting constructions may be used so long as they provide the proper anchorage and operation of the torque spring.

Figure 36 is a section taken through the forwardly projecting stud 15'' of Figure 31 which is properly secured to the engine unit. The stud 15'' is received in the eye of the spring 83 and the bushing 84' which is made of rubber or any other proper material serves to provide the required pivotal motion at this point along with resilient resistance to a slight amount of movement in any direction. The bushing 84' has provided thereon the flange portions 92 to rest between the spring 83 and the cover plate of the engine unit 1 on one side and between the spring and the washer 90 on the other side in such a manner as to resiliently restrict movement of the engine unit in the fore and aft directions.

Figure 37 is a section taken at the rear of the engine unit as shown in Figure 32. The rearwardly projecting portion 30b of the engine unit rests directly in the bushing 89 which is formed of rubber or any other proper material so as to provide the desired pivotal motion at this point, plus resilient resistance to a slight amount of movement in all directions. The bushing 89 has provided thereon the flange portions 93 which rest between the spring and the flange 94 at one side and between the spring and the washer 91 on the other side thus serving to resiliently restrict any movement of the engine unit in an endwise manner with respect to its frame.

The bushings for the front and rear mountings may be provided with the portions for the restriction of endwise movement of the engine unit with respect to its frame as shown and described in Fisures 36 and 37, or the flange por-

tions may be eliminated and a straight bushing used where it proves satisfactory. The flange parts **92** and **93** of Figures 36 and 37, while being referred to as being parts of the bushings, may, if desired, be made from extruded rubber cut to the proper lengths to form rubber washers and fitted on either side of the eyes of the springs thereby giving a construction of low cost and simple assembly.

Whereas these bushings, as stated in the foregoing, are to be constructed of rubber or any other proper material, they may, if so desired, be made of bronze, steel, or any other proper metallic substance where the resilient opposition to a slight amount of movement in all directions and the benefits of sound and vibration deadening qualities of rubber are not required.

In Figures 11 through 19, 22 and 28 we show rear mounting constructions, any one of which may be used with any form of front mounting construction as set forth in this patent, or with any other front mounting construction and stabilizer construction if needed. All of these rear mounting constructions will under any and all conditions quite closely though resiliently preserve the position of the adjacent end of the axis of oscillation, while permitting torque cushioning oscillation about said axis, in some cases said torque cushioning effect being absorbed wholly by the front mounting, or by a stabilizer, or by combined stabilizer and front mounting, and in other cases by both the front and rear mounting, or even by the rear mounting alone or combined with a stabilizer.

Figures 11, 12, 13, 19, 22 and 28 show constructions which assist in resiliently opposing the torque forces of the engine unit in a greater or lesser degree.

Figures 14–18 serve to very closely define and preserve the position of the adjacent end of the axis of oscillation and in no way assist in resiliently opposing the effects of the torque forces of the engine unit.

In our experimenting with front mounting constructions, we have learned that various forms and shapes of springs are necessary to obtain the results desired for various peculiar sets of conditions, along with the proper angular positioning with respect to the axis of oscillation of the attaching end of the spring, whether it be to the supporting member or the engine unit. More specifically, every different angle at which the attaching end is allowed to rest gives a different set of transverse and vertical resilient resisting forces.

In Figures 3, 4 and 6 we show an eyed C-spring identical in form in each case and rigidly attached to the supporting member, but by virtue of its positioning and the disposal of the attaching portion we secure three distinct sets of results, any of which might be used, or any one of which might be preferable under any given set of conditions.

In Figure 6A we show a supporting bracket formed to fit the spring which spring is identical with those mentioned above in Figures 3, 4 and 6, on a portion of its curve. This supporting bracket would tend to increase the resilient resistance to the transverse forces set up by the engine unit, whereas without the arcuate supporting portion as shown in Figure 6 the result is to reduce the resilient opposition to the transverse forces. Hence, different values of transverse opposition forces can be arrived at by varying the length of the arcuate portion.

In Figure 5 we show an eyed C-spring with a reverse curve and rigidly attached to the supporting member, which in some cases may be far too flexible and yet in others may give the ideal front mounting construction where the proper lengths and relations of the spring curves are arrived at.

Figures 7 and 8 show front mounting constructions wherein identical eyed C-springs are used, but the position and angles at which they are attached to the engine unit 1 are different and provide different relative vertical and horizontal resilient resistance and are therefore suited to different sets of conditions.

Figures 9 and 10 show two different front mounting constructions wherein two different one-piece double-ended eyed C-springs are used. Figure 9 shows a construction wherein the spring is attached to the supporting member and Figure 10 shows a construction wherein the spring is attached to the engine unit.

In all the front mounting constructions shown, the level of the eyes is substantially at the center of oscillation of the engine unit at this point, the variation being chiefly in the transverse location of the eyes with respect to the said axis of oscillation and in the method and the angle of attachment of the spring to either engine or support.

Having now described our "eyed axis-locating engine unit mounting", what we claim as new and desire to protect by Letters Patent is as follows:—

1. In a vehicle, the combination of an engine unit and at least two longitudinally spaced resilient mounting structures supporting the engine unit and supported by the vehicle and constructed and arranged to provide for resiliently opposed transverse movement in any direction, combined with resiliently opposed torque cushioning oscillation about a longitudinally extending axis approximately intersecting the axis of the engine crankshaft adjacent the rear mounting structure and being spaced above the crankshaft axis adjacent the front mounting structure, at least one of said mounting structures being composed of resilient metallic means providing for resiliently opposed movement in at least two directions and connected to the vehicle and to the engine unit, at least one of said connections being pivotal, said pivotal connection of said resilient metallic means being approximately at the height of said axis of oscillation.

2. In a vehicle, the combination of an engine unit, and at least two longitudinally spaced, resilient mounting structures supporting the engine unit and supported by the vehicle and constructed and arranged to provide for resiliently opposed transverse movement in any direction, combined with resiliently opposed torque cushioning oscillation about a longitudinally extending axis approximately intersecting the axis of the engine unit crankshaft adjacent the rear mounting structure and passing through substantially the entire length of the engine unit, at least one of said mounting structures being composed of resilient metallic means providing for resiliently opposed movement in at least two directions and connecting the engine unit and the vehicle, one of said connections of the resilient metallic means having pivotal supports located approximately at the height of said axis of oscillation and on opposite sides thereof.

3. In a vehicle, the combination of an engine unit, and at least two longitudinally spaced resilient mounting structures supporting the engine

unit and supported by the vehicle, said resilient mounting structures being constructed and arranged for yielding movement of the engine unit in all directions, at least one of said mounting structures being composed of resilient metallic means providing for resiliently opposed movement of the engine unit and connected to the engine unit and to the vehicle, one of said connections including pivotal connecting means, the pivotal connecting means of said resilient mounting means being located to determine a pivotal point for said structure about which the engine unit may oscillate.

4. In an automotive vehicle, the combination with an engine unit, of at least two longitudinally spaced resilient mounting structures for providing for transverse cushioning in any direction combined with torque cushioning oscillation about a longitudinally extending axis, at least one of said mounting structures being composed of metallic resilient means providing for resiliently opposed movement in at least two directions extending transversely of the vehicle and connecting the vehicle and the engine unit, one of said connections of said metallic resilient means being pivotal, the other of said connections being clamped whereby to locate one end of said axis of oscillation by the location of the pivotal connection of said metallic resilient means.

5. In an automotive vehicle, the combination with an engine unit, of at least two longitudinally spaced resilient mounting structures having connections with the engine unit for providing for transverse cushioning in any direction combined with torque cushioning oscillation about a longitudinally extending axis extending through substantially the entire length of the engine unit, at least one of said mounting structures being composed of metallic resilient means providing for resiliently opposed movement in at least two directions extending transversely of the vehicle and the engine unit, one of said mounting connections being pivotal, whereby the height of the pivotal connection of said metallic resilient means will act to determine the height of one end of said axis of oscillation.

6. In a vehicle, the combination of an engine unit, and at least two longitudinally spaced resilient mounting structures supporting the engine unit and supported by the vehicle, at least one of said mounting structures at the front of the engine unit comprising metallic resilient means providing for resiliently opposed oscillatory movement of the engine unit and connected to the engine unit and to the vehicle, one of said last-mentioned connections having pivotal connecting means located on diametrically opposite sides of a pivotal point determined by said mounting structure and about which the engine unit oscillates, which pivot point is on an axis passing through the center of mass of the engine unit and intersecting the crankshaft axis adjacent the rear end of the engine unit.

7. In an automotive vehicle, the combination with an engine unit, of at least two longitudinally spaced resilient mounting structures for providing for transverse cushioning in any direction, combined with torque cushioning oscillation about a longitudinal axis, at least one of said mounting structures comprising metallic resilient means providing for resiliently opposed movement in at least two directions extending transversely of the vehicle and connecting the vehicle and the engine unit, one of said connections of said metallic resilient means being pivotal, whereby to locate one end of said axis of oscillation by the location of the pivotal connection of said metallic resilient means.

8. In a motor vehicle having a frame and an engine unit, the combination of at least two longitudinally spaced resilient mounting structures mounting the engine on the frame and providing for torque cushioning oscillation of the engine unit about a longitudinally extending axis passing through the center of mass of the engine unit and intersecting the crankshaft axis adjacent the rear end of the engine unit, at least one of said mounting structures at the front of the engine unit comprising metallic resilient means extending transversely of the vehicle and connecting the engine unit with the frame, at least one of said last-mentioned connections being pivotal and the other of said connections being fixed whereby to locate one end of said axis of oscillation by the location of the pivotal connection of said metallic resilient means.

9. In a motor vehicle having a frame and an engine unit, the combination of resilient means mounting the engine unit on the frame and providing for torque cushioning oscillation of the engine unit about a longitudinally extending axis, said mounting means comprising transversely extending bowed leaf-springs yielding to movement of the engine unit in all directions and connecting the engine unit with the frame, one end of each leaf-spring being clamped and the other end being secured against transverse movement by a fixed pivot, the pivots of the springs being located approximately at the height of the axis of oscillation and on opposite sides thereof.

10. In a motor vehicle, the combination with an engine unit having a tendency to oscillatory movement during operation about a longitudinal axis, of means for mounting said engine unit in the vehicle and providing for oscillatory movement of the engine unit, said mounting means comprising a pair of bowed leaf-springs having pivotal connections with the front end portion of the engine unit at points spaced a substantial distance above the crank-shaft of the engine unit, said pivotal connections being located approximately in horizontal alignment with the axis of oscillation therebetween.

11. In a motor vehicle, the combination of an engine unit, and at least two longitudinally spaced resilient mounting structures supported by the vehicle and supporting the engine unit for oscillatory movement about a longitudinal axis extending through the center of mass of the engine unit and intersecting the crankshaft axis adjacent the rear end of the engine unit, the mounting structure adjacent the front end of the engine unit being metallic and having a pivotal connection with the engine unit approximately at the height of the axis of oscillation.

ROLLAND S. TROTT.
W. VINCENT THELANDER.