June 3, 1930. C. R. SHORT 1,761,938

ENGINE MOUNTING

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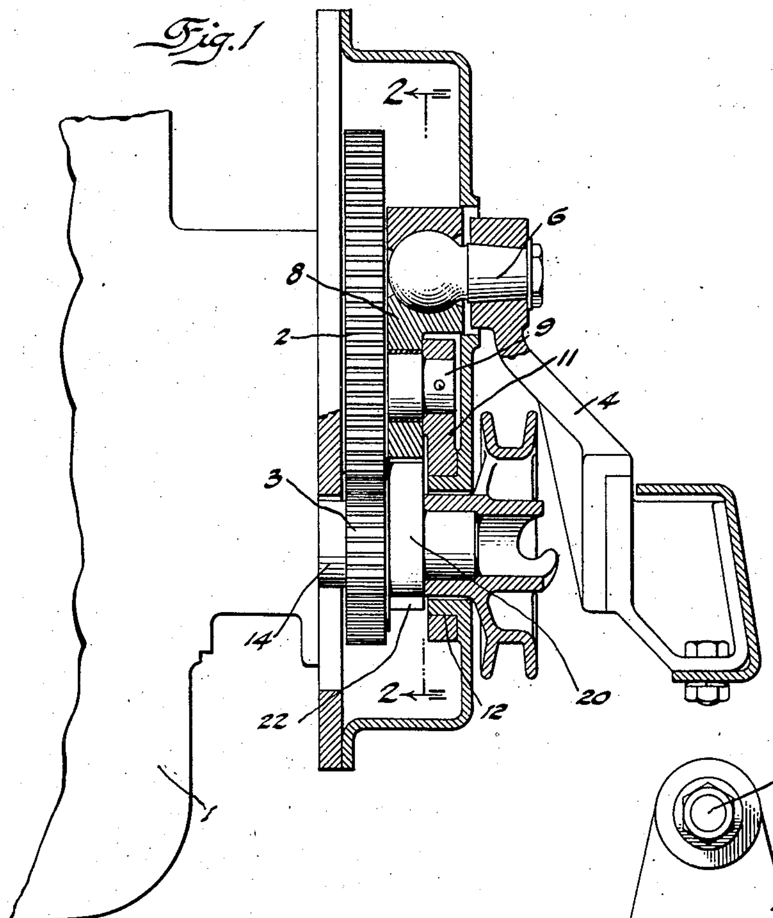
Fig. 1



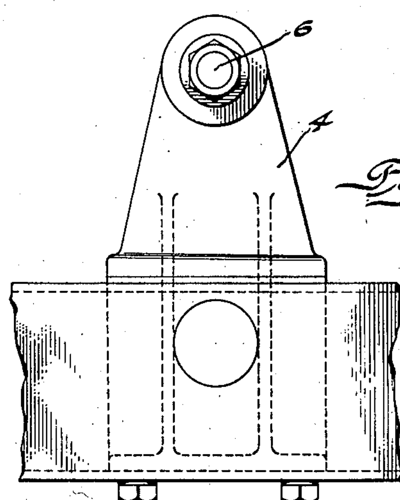


Fig. 3

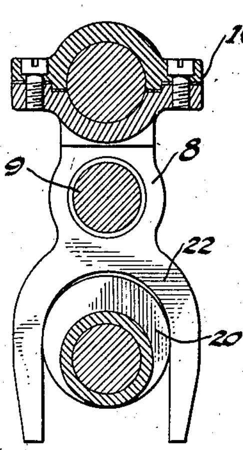


Fig. 2

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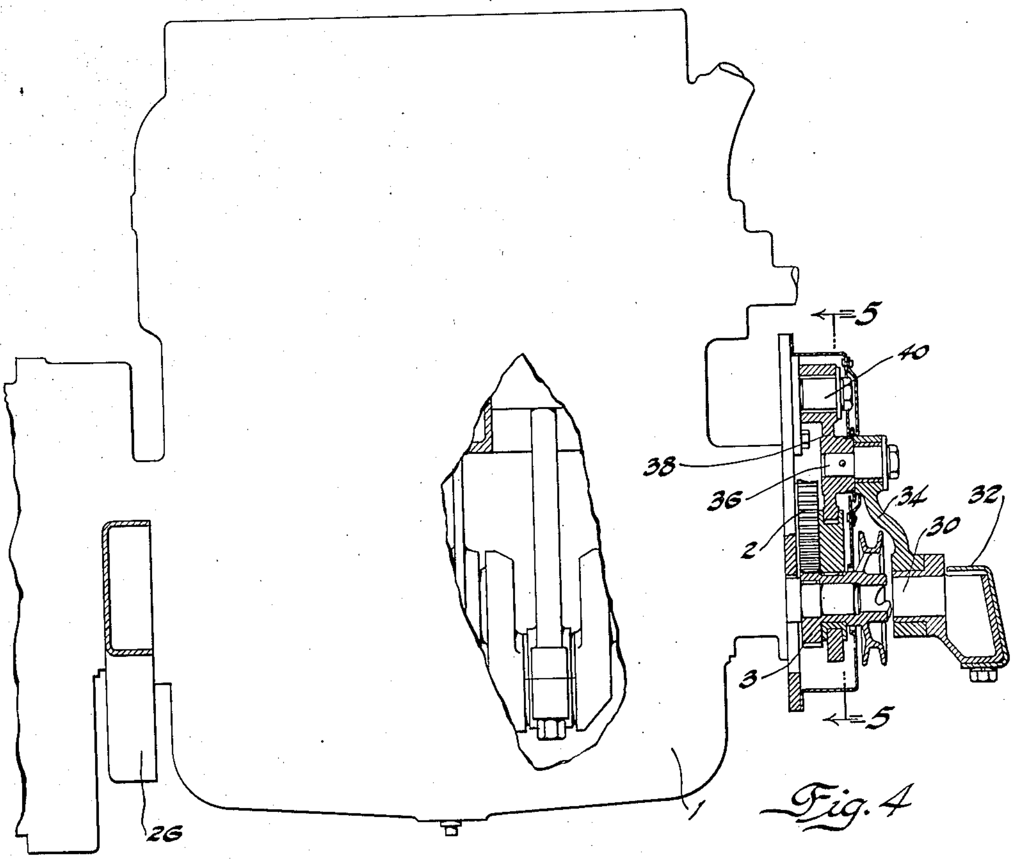

Fig. 4

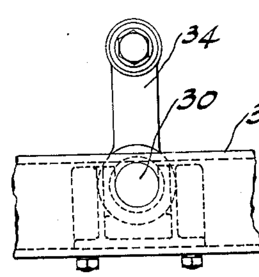

Fig. 6

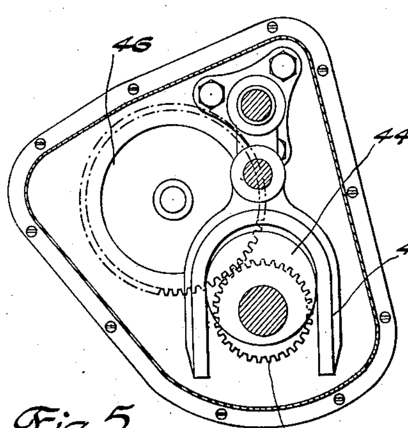

Fig. 5

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Patented June 3, 1930

1,761,938

UNITED STATES PATENT OFFICE

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ENGINE MOUNTING

Application filed March 1, 1926. Serial No. 91,506.

This invention relates to mountings for engines of the type employing a crankshaft and reciprocating pistons, and particularly to mountings of the character disclosed in the application of Caleb E. Summers and Roger Kenneth Lee, Serial No. 77,885, filed Dec. 26, 1925. In that application forms of engine mounting are disclosed which prevent transmission to the vehicle frame of certain engine vibrations, in particular the vibrations at double crankshaft frequency caused by inertia forces resulting from the movement of the reciprocating parts, that is, the pistons and connecting rods, which in four cylinder engines are inherently out of balance. It has been found that these vibrations are of constant amplitude at all engine speeds and the forms of engine mounting disclosed in said application take advantage of this fact by shifting the engine supports in synchronism with the movements of the engine to the same extent and in the same direction that the engine is moved by the vibrations, so that the pressure exerted by the engine on the frame remains constant and the frame does not vibrate.

In the present application I disclose an engine mounting for accomplishing the same result. In my construction the engine supports form a positive connection between the engine and the frame and are of such character that they may be directly moved by the engine crankshaft although shifting of the supports must take place at the same frequency as the vibrations, which is double crankshaft frequency. In detail, my invention consists of a pair of links pivoted together, one of the links being also pivoted to the supporting frame and the other to the engine. By moving the pivot which connects the two links back and forth preferably by means of a cam on the crankshaft, I obtain a raising and lowering of the engine supports at the desired frequency. This prevents transmission to the frame of the corresponding engine vibration.

Referring to the drawings:

Figure 1 is a view partly in section showing one form of my invention.

Figure 2 is a view on line 2—2 of Figure 1.

Figure 3 is a side elevation of the supporting bracket.

Figure 4 is a view of an automobile engine showing another form of mounting.

Figure 5 is a section on line 5—5 of Figure 4.

Figure 6 is a side elevation of the part of the supporting means which is directly connected to the frame.

In Figure 1 I have indicated at 1 a portion of a conventional four cylinder automobile engine having a crankshaft, pistons and connecting rods connecting the pistons to the crankshaft. The reference characters 2 and 3 indicate the conventional timing gears by means of which the cam shaft is driven from the usual crankshaft.

As set out in the application of Summers and Lee, previously referred to, four cylinder engines of this type are subject to vibration caused by the inherent unbalance of the reciprocating parts,—that is, the pistons and connecting rods. This vibratory force may be resolved into two components, one acting in a vertical direction causing up and down movement of the engine, and the other acting in a horizontal direction causing oscillation of the engine about a longitudinally extending horizontal axis. It may be demonstrated that these vibrations are of fixed amplitude at all engine speeds. It may also be demonstrated that the movement of the engine in a vertical direction is not a pure movement of translation but is a tilting movement about an imaginary transverse axis which, with certain engines, is found to be located in the vicinity of or slightly to the rear of the transmission housing. My improved motor support is so designed as to effect vertical movements of the support for the front end of the engine in synchronism with the vibratory movements of the engine in this direction.

As shown in Figure 1 the supporting means consists of a bracket 4 carrying a stud 6 having a ball shaped end. From this end of the stud is suspended a link 8 having a split bearing indicated at 10 for encircling the ball. To the link 8 is pivoted at 9 a link 11, which supports the front end of the engine, the lower end of the link being swivelled about collar 12 formed integrally with a portion of the engine housing and encircling the engine crankshaft indicated at 14. Upon the crankshaft is also secured eccentric 20 which is straddled by fork 22 formed on the lower end of link 8. The rear end of the engine may be supported either in the manner set forth in the prior application of Summers and Lee, above referred to, or by a simple connection to cross member 26, shown in Fig. 4, the cross member being located in the vicinity of the transverse axis about which vertical vibrations of the engine takes place, the resilience of the cross member being relied upon to permit the slight up and down motion imparted to the front end of the engine by my improved mounting.

The operation is as follows: When the engine is at rest the centers of the stud 6, pivotal connection 9, and collar 12 will be in vertical alinement and the point of support of the front end of the motor will be in its lowermost position. When the crankshaft is rotated cam 20 will swing link 8 back and forth carrying the pivotal connection 9 first to one side and then to the other side of the line of centers of the stud 6 and collar 12. This will effect an alternate decrease and increase in the over-all vertical length of the links and consequently alternate raising and lowering of the point of support of the engine. Thus, starting with the centers in line, during one revolution of the crankshaft the pivotal connection 9 will be swung first to the left of the line of centers raising the point of support, then back to mid position lowering the point of support, then to the right of the line of centers raising the point of support and then back to mid position, again lowering the point of support. Thus the point of support of the engine will be moved up and down twice during each revolution of the engine crankshaft, in other words, it will be oscillated in a substantially vertical direction at double crankshaft frequency. The cam 20 is so designed that the movement of the point of support synchronizes with the movement of the engine resulting from the vibratory forces, is equal in extent to said movement and is at all times in the same direction. However, there will also be a slight lateral movement of the engine as a result of the reaction upon the engine of the force exerted by the cam against the fork, for this force must be sufficient to overcome the friction at the various link pivots and as the links always support the same motor load this friction will be considerable. If desired, this lateral movement may be avoided by providing suitable guides for holding the engine against any movement except in a vertical plane.

The exact phase relationship of the movement of the vibrating body, as the engine block, to the cycle of movements of the unbalanced parts, as the reciprocating elements of the engine, may be most conveniently determined empirically. For this purpose the machine or engine may be supported upon very long and flexible springs and set into operation. The direction, amplitude and phase relationship of the vibratory movements may then be readily observed. In the case of an engine of the type illustrated, viz., a four cylinder vertical engine with the two intermediate cranks on the same side of the crankshaft and at 180° from the two end cranks, the direction of the vibrations at the points of support will be approximately vertical. The center of gravity of the reciprocating parts in this type of engine rises and lowers twice during each revolution of the cranks, being highest when the two pairs of pistons and corresponding cranks are, respectively, at top and bottom dead centers and lowest when the cranks are at 90° from this position. A mechanism suspended in such a way that it is free to move in all directions tends to maintain its total center of gravity fixed in space. Therefore, if the center of gravity of a part of the mechanism moves in one direction the remainder of the mechanism tends to shift in the opposite direction. Accordingly, in the present instance, the engine block tends to assume its highest position, in response to the inertia forces of the reciprocating parts, when the cranks are in a horizontal position and its lowest position when the cranks are at top and bottom dead centers, the intermediate positions following substantially a sine curve. The amplitude of movement may also be derived from the computation of the disturbing force, by well known text-book methods, and a comparison of respective masses of the reciprocating and non-reciprocating parts.

In the form shown in Figures 4 to 6, 30 indicates a supporting bracket secured to the vehicle frame 32. Upon the bracket is journaled link 34 which extends upwardly and carries stud 36 forming a pivot for lever 38 which is pivoted at its upper end to stud 40 rigid with the engine housing and serving to support the latter. The lower end of the lever 38 is forked as at 42 to encircle cam 44 on the crankshaft.

This form of the invention operates in the same manner as that previously described. It is to be noted, however, that the system is in unstable equilibrium, the weight of the front portion of the engine being applied at 40 through a system of pivoted levers to bracket 30 located below the point of application of the weight. With this form of device it will probably be necessary to provide guides for the engine housing as previously described.

I claim:

1. The combination of a machine subject to vibrations of substantially fixed amplitude and direction, a support, suspension means connecting the machine and the support, and

means for positively moving said connecting means in synchronism with said vibrations so as to cause the point of support to follow the machine in its vibratory movement to prevent transmission of vibrations to the support.

2. The combination of a machine subject to vibrations of substantially fixed amplitude and direction, a support, flexible means for suspending the machine from the support, and means for changing the overall length of said flexible means in synchronism with said vibrations so as to cause the point of support to follow the engine in its vibratory movement to prevent transmission of vibrations to the support.

3. An engine having a driven shaft, and subject to vibrations of substantially fixed amplitude and direction, means for supporting the engine comprising a support and swingable suspension means between said support and engine, and means on said shaft for directly swinging said means in synchronism with said vibrations so as to cause the point of support to follow the engine in its vibratory movement to prevent transmission of engine vibrations to the support.

4. The combination of an engine subject to vibrations of substantially fixed amplitude and direction, a support, flexible suspension devices between said engine and support, and means for varying the overall length of said devices in synchronism with said vibrations so as to cause the point of support to follow the engine in its vibratory movement to prevent transmission of vibrations to the support.

5. An engine having a driven shaft and subject to vibrations of substantially fixed amplitude and direction, a support, flexible suspension means between said support and said engine, and means on said shaft for directly operating said suspension means in synchronism with the vibrations set up in said engine so as to cause the point of support to follow the engine in its vibratory movement to prevent transmission of vibrations to the support.

6. In the combination as defined in claim 5, said connections comprising a pair of links pivoted together, one of the links being pivoted to the engine and one to the support.

7. The combination of an engine subject to vibrations of substantially fixed amplitude and direction, a frame, a link pivoted to the frame, a link pivoted to the engine, a pivotal connection between said links, and means for shifting said pivotal connection in synchronism with said vibrations so as to cause the point of support to follow the engine in its vibratory movement to prevent transmission of vibrations to the support.

8. The combination of an engine, a support, means for connecting the engine to the support comprising a pair of pivoted links swung from the support, one of said links having pivotal connection with the engine, and means operated by the engine for swinging the pivotal connection between said links comprising a cam operated by the engine and a fork on one of said links engaging the said cam.

In testimony whereof I affix my signature.

CHARLES R. SHORT.