

May 24, 1938.

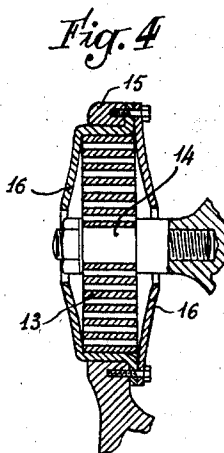
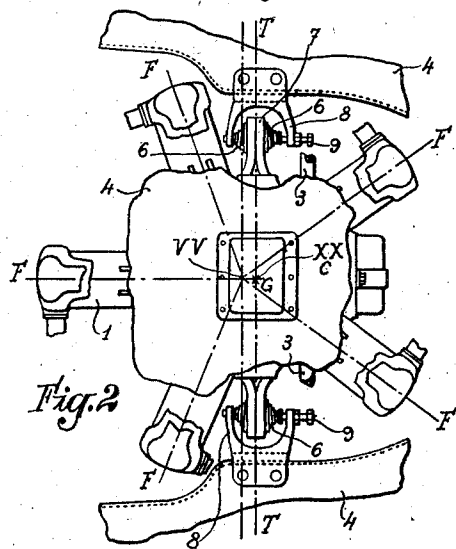
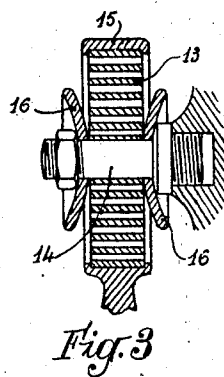
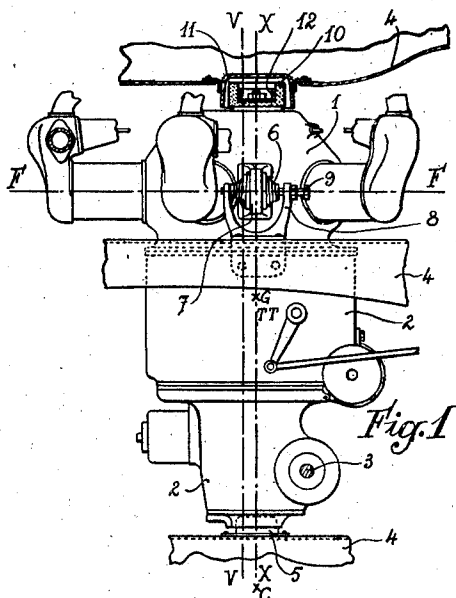
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2,118,550

MOUNTING OF RADIAL CYLINDER ENGINES

Filed May 15, 1937

4 Sheets-Sheet 1



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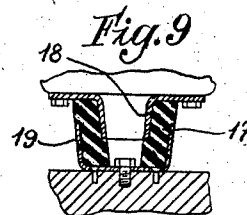
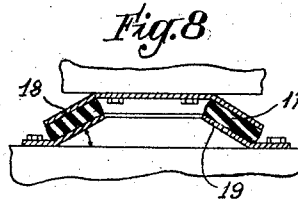
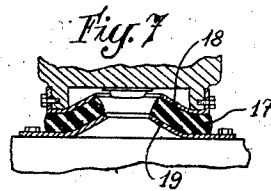
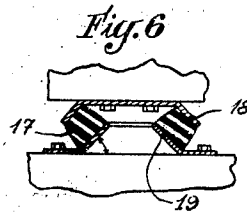
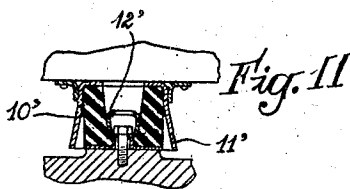
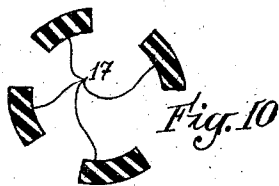
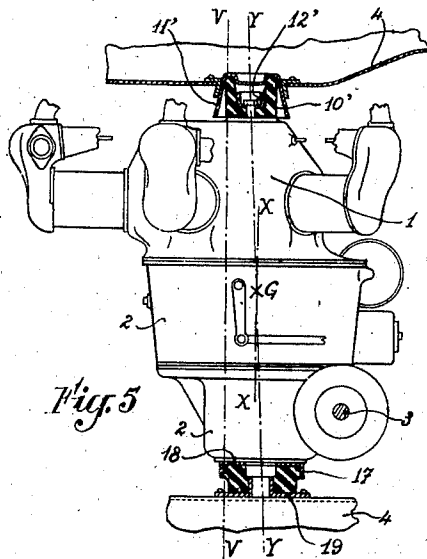
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2,118,550

MOUNTING OF RADIAL CYLINDER ENGINES

Filed May 15, 1937

4 Sheets-Sheet 2



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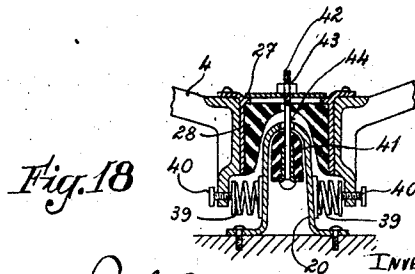
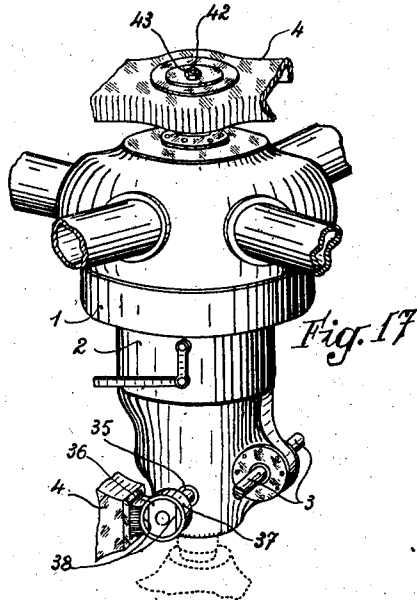
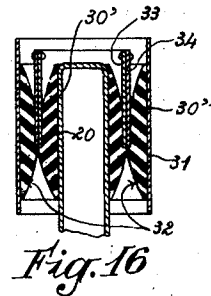
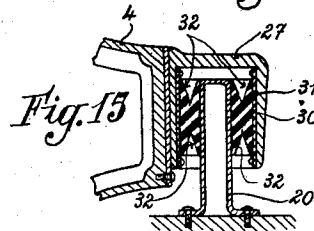
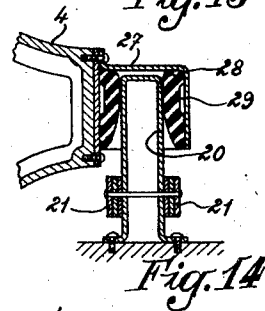
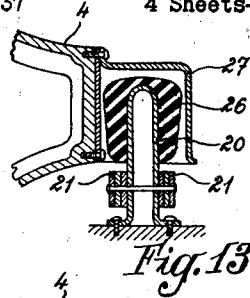
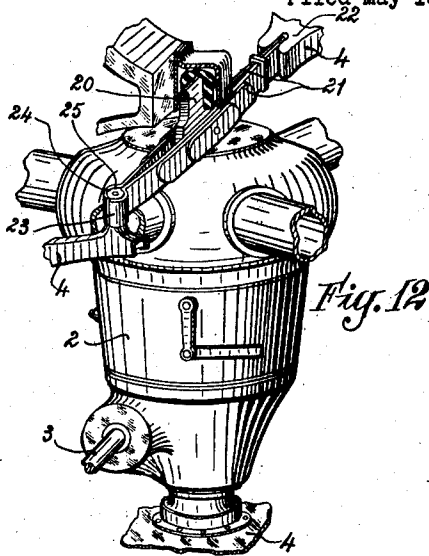
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MOUNTING OF RADIAL CYLINDER ENGINES

Filed May 15, 1937

4 Sheets-Sheet 3



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2,118,550

MOUNTING OF RADIAL CYLINDER ENGINES

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Fig. 19

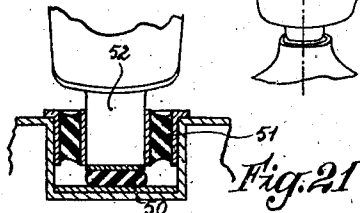
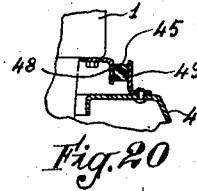
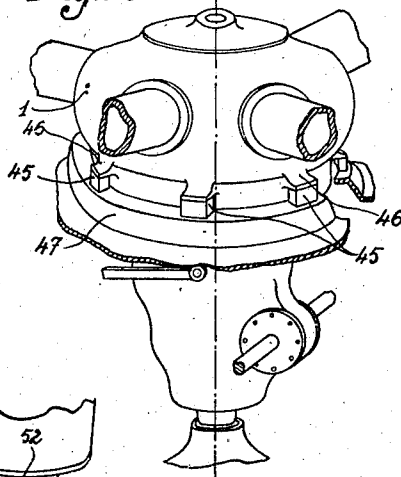


Fig. 22

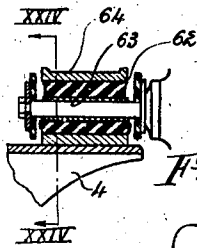
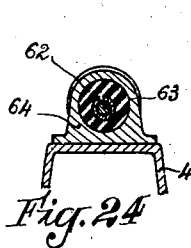
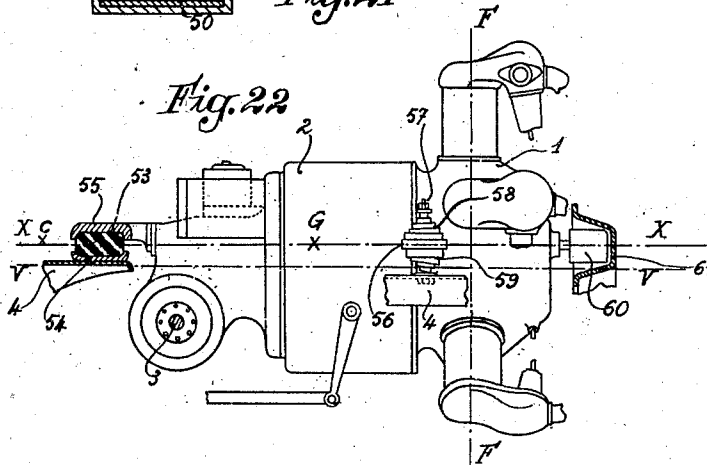


Fig. 23

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UNITED STATES PATENT OFFICE

2,118,550

MOUNTING OF RADIAL CYLINDER ENGINES

Paul Charles Albert Marie d'Aubarede, Saint-Genis-Laval, France

Application May 15, 1937, Serial No. 142,900
In Germany and Italy May 18, 1935

10 Claims. (Cl. 180—64)

This application is a continuation in part of my copending application Serial No. 22,481 filed May 20, 1935, now Patent 2,084,080.

The mounting according to the present invention is intended for radial cylinder engines in which the motor shaft drives a gear box with bevel gears or the like through which power is transmitted to shafts which in general directly drive the front or rear wheels of a vehicle, the gear box being carried with the engine casing.

In such a case, the power shaft or shafts are at a substantial angle with the machine shaft and they therefore produce a transverse torque on the machine, different from the internal periodic torques. The engine may thus be mounted according to my aforesaid Patent 2,084,080. But the particular arrangement of the engines of the kind referred to gives rise to some difficulties.

It must be pointed out that in a radial cylinder engine the resultant of the periodic forces deriving from the movement of the reciprocating parts is not directed along a fixed line of action but rotates in the plane of the cylinder axes. For each instantaneous position of this resultant there exists an axis about which the engine would tend to oscillate under the action of this periodic resultant if the line of action thereof were immovable; since this line of action rotates, the oscillation axis may be considered as also rotating and the engine therefore oscillates conically about a centre of oscillation.

According to the present invention a radial cylinder engine of the kind above-referred to is mounted as explained in my aforesaid Patent 2,084,080, the yielding or flexible connection and the spring means being arranged to permit the conical oscillation of the engine.

Moreover the spring means may be advantageously formed by a rubber block or rubber blocks of appropriate resilient properties; the rubber block forming the spring means may also form the limiting abutment and operate as an arresting filter.

In the annexed drawings:

Fig. 1 is a side view of an engine mounted according to the present invention.

Fig. 2 is the corresponding plan view.

Figs. 3 and 4 show in longitudinal section two modifications of the spring means.

Fig. 5 shows a modified mounting.

Figs. 6, 7, 8 and 9 show possible embodiments of the lower connection.

Fig. 10 diagrammatically shows in horizontal section a lower connection formed of a plurality of rubber blocks.

Fig. 11 is a vertical section of a modification of the elastic abutment.

Fig. 12 is a perspective view of another form of mounting, the limiting abutment being shown in section.

Fig. 13 shows in section the upper limiting abutment.

Figs. 14 to 16 are sections of limiting abutments having an elastic action.

Fig. 17 is a perspective view of a mounting in which the upper limiting abutment forms the spring means.

Fig. 18 shows another form of limiting abutment combined with springs.

Fig. 19 is a perspective view of another mounting comprising rubber blocks to form springs about the engine.

Fig. 20 is a section of a modification.

Fig. 21 is an enlarged section of the lower connection.

Fig. 22 is a side view of a mounting in which the engine is supported with the motor axis horizontal.

Figs. 23 and 24 are longitudinal and transverse sections of a modified form of connection for the mounting of Fig. 22.

The machine shown for example in Figs. 1 and 2 is an engine for directly driving the front or rear wheels of a vehicle. It comprises an internal combustion engine proper 1, with vertical motor axis (crankshaft axis) and radially disposed cylinders. A gear box 2—2 forms change speed gearing and also encloses bevel gears or the like and a differential gearing. Two opposed transverse shafts 3 protrude from the gear box and they directly drive the wheels through appropriate joints.

V—V is the geometrical axis of the motor shaft (crankshaft); G is the centre of gravity of the engine assembly located at a distance from V—V; X—X is an axis parallel to V—V and passing through G; F—F are the cylinder axes forming an horizontal plane; T—T is a transverse axis passing through G and parallel to the axis of shafts 3.

The internal periodic forces resulting from the movement of the reciprocating parts (pistons, connecting rods) have a resultant which rotates in the plane F—F. The direction and speed of rotation of this force (with respect to the motor speed) depend upon the characteristics of the engine (number of cylinders, arrangement of the connecting rods, etc.).

If we consider a fixed vertical plane containing X—X, the component of this rotating resultant

in this plane is a periodic force which, if separately applied to the engine, would tend to oscillate the same about a certain point C of axis X—X, as explained in my prior U. S. Patent 2,055,279. And since the same reasoning might be applied to any vertical plane containing X—X, point C is the natural centre of a substantially conical oscillation of the engine under the action of the periodic forces, the axis of the cone being approximately X—X.

This point C is submitted to the same actions as the transverse axis c—c defined in my aforesaid U. S. Patent 2,055,279 i. e., it is the natural centre of conical oscillation under the action of the periodic forces and of the spring means and its exact position is somewhat variable.

The engine is also submitted to the action of the internal periodic torques resulting from the exchange of energy between the flywheel and the connecting rods as explained in my prior U. S. Patent 2,055,279; these torques tend to oscillate the engine about a natural axis X—X passing through G and parallel to the motor axis V—V.

And as explained in my said patent 2,084,080 owing to the transverse position of the driving shafts or power shafts 3 and to the unavoidable irregularities of the power torque, the engine is also submitted to a transverse periodic torque which tends to oscillate it about an axis T—T passing through G and parallel to shafts 3.

The engine is of course to be maintained against the action of the average power torque delivered by shafts 3, which torque may reach rather high values.

The machine is supported by a lower beam of the frame 4 through a block or cushion 5 of rubber glued or otherwise retained in place. This block is located on axis X—X at a position intermediate between point C and the centre of gravity G. The action of the periodic portion of the power torque is preferably reduced as explained in my co-pending application Serial No. 132,151 filed March 20, 1937, by means of an elastic coupling in such a manner that the connecting block 5 may be disposed in the vicinity of point C as shown, the tendency of the engine to oscillate about T—T being materially reduced.

Of course point C will vary in position within certain limits but we consider its average position and block 5 is yielding enough to accommodate these variations.

Since block 5 substantially supports the weight of the engine, the spring means have mainly to retain the engine assembly against the action of the average driving torque which tends to rotate it about a transverse axis. In the mounting shown, these spring means comprise two spring systems, diametrically opposed to one another, each embodying two inverted conical springs 6 resting against a common vertical base 7 fixed to the engine and against the arms of a forked member 8 fixed to the frame 4. A screw 9 permits of adjusting the springs. The radial pitch of the springs must be large enough to accommodate the conical oscillations of the engine.

These springs must operate as an "arresting filter" for the conical oscillations about C, as well as for the oscillations about X—X or T—T and at any normal engine speed. They have also to support the average driving torque exerted by shafts 3. The latter may reach high values but it is rather easily supported by block 5 and by springs 6 on account of the material vertical distance between said springs and said block. It is moreover possible to provide these springs with

an elastic reaction increasing with the load, as explained in my co-pending application Serial No. 10,075 filed March 8, 1935, this being obtained in the example shown by a progressive contact of the windings against base 7, starting with the larger ones.

There is arranged at the upper end of the engine and on axis X—X a limiting abutment, as in the mounting described in my said Patent 2,084,080, this abutment comprising a rubber block 10 housed with play within a box 11 fixed to the frame 4. The box is preferably slightly frusto-conical as shown to provide a progressive bearing for the block and the latter is preferably fixed by means of an inverted cup-shaped member 12 which leaves the upper part thereof free to yield, which avoids any shock.

In lieu of the spring means described there could be used for each spring system a single spiral spring as shown in Figs. 3 and 4. The spring 13 of Fig. 3 is fixed at its centre on a pin 14 carried by the frame (or by the engine) and its larger winding is fixed to a ring 15 carried by the engine (or, respectively, by the frame). In order to obtain an elastic reaction increasing with the load, cups 16 are fixed on pin 14 on both sides of the spring, the windings of the latter resting progressively against one of said cups when the spring is loaded above a certain limit.

In Fig. 4 the arrangement is similar, but the cups are in the form of cheeks fixed to ring 15.

The radial pitch of spring 13 is such that it accommodates the normal conical oscillations of the engine.

In the mounting illustrated in Fig. 5 the connection and the limiting abutment are situated on an axis Y—Y passing through G and slightly different from axis X—X. When the angle of Y—Y and X—X is small, this difference is without any inconvenience and the practical construction is often rendered easier.

The lower connection is a rubber block 17 glued between plates 18 and 19, the first one forming a box which surrounds the block while the second one has a central projection traversing the same. If the rubber is not exaggeratedly soft and yielding, this connection supports easily the weight of the engine and permits a sufficient degree of freedom for the choice of the point of oscillation of the same in its vicinity.

The upper limiting abutment forms at the same time the spring means. The rubber block 10' fits into the bottom of the inverted frusto-conical box 11' and the inner cup-shaped member 12' is rather short. When the zone of contact between the inner wall of box 11' and block 10' remains above the horizontal plane of the upper end of member 12', the device works as a spring. When the displacements of the engine become too large, the rubber is compressed between box 11' and member 12' and the device operates as a limiting abutment.

In Fig. 5 the upper part of block 10' is merely held in the bottom of box 11' which projects along the inner edge of the block as shown. In the modification shown in Fig. 11, block 10' is glued to box 11' which therefore has no central projecting part. The double operation of the block is here clearly grasped: when the oscillations of the engine are small, it operates as a spring, but as soon as they become abnormally large, it forms a limiting abutment.

Figs. 6 to 9 show modified forms of connections in which plates 18 and 19 are conical. It will be

observed that the member shown in Fig. 9 may also form an elastic abutment for the upper end of the engine if the rubber is very soft.

The rubber block 17, in the case of Figs. 6 to 8, may be formed of separate sectors, as shown in Fig. 10, instead of a continuous ring.

In the mounting of Fig. 12 the engine is supported by a lower connection of any kind, for instance similar to the connection shown in Fig. 5, this connection being disposed as above explained. The upper part of the engine is provided with a sort of flat nose 20 to which are fixed two leaf springs 21. One end of these springs is freely slidable within the slit of a member 22 fixed to the frame while the other one is formed into a sleeve 23 surrounding a tubular member 24 made of rubber and supported by a finger 25 fixed to the frame 4.

Springs 21 resist the average torque and they permit the oscillations of the engine owing to their transverse elasticity and also owing to the compressibility of member 24 which allows a certain amount of longitudinal displacement of the springs.

The limiting abutment is detailed in Fig. 13. It comprises a mass 26 of rubber glued or otherwise fixed on nose 20 and housed with play within a box 27 fixed to the frame 4. It is inactive, or substantially so, for oscillations deriving from the periodic stresses under normal operating conditions, but in the case of shocks, abnormally high driving torques, etc., it limits the angular displacement of the engine. This abutment is square or rectangular in cross-section.

In the modification of Fig. 14 the rubber layer 28 is fixed to the inner walls of box 27 and no play is provided between this rubber and nose 20. But the rubber coating is curved in section and there is provided an annular chamber 29 between the rubber and the walls of box 27 at the level of the line of contact between the rubber layer and nose 20. Owing to this chamber 29 the rubber does not substantially prevent the small oscillations of nose 20, but when the same become too great, the zone of contact extends above and under chamber 29 and the rubber is fully compressed. This abutment has an elastic action and acts as a spring to a more or less limited extent.

The limiting abutment of Fig. 15 operates as a spring and when it is used in the mounting of Fig. 12 springs 21 are omitted. This abutment comprises a layer 30 of rubber glued on nose 20 and to a tubular sheet or casing 31 of metal, square or oval in cross-section. The rubber is deeply grooved, as shown at 32, between nose 20 and casing 31. The tubular casing is engaged into box 27 as shown and fixed therein.

For the small displacements of the engine the rubber is mainly compressed in the plane corresponding to the deepest portion of the grooves, where the active section is small. When the displacements of the engine become abnormally large, the zone corresponding to the bottom of the grooves is fully compressed and the grooves tend to close. In the first case the elastic reaction is moderate and the abutment acts as a spring; in the second case the elastic reaction is considerable and the abutment operates as a limiting abutment proper.

In the modification of Fig. 16 the mass of rubber is divided into two parts, the first one 30' being fixed to nose 20 and the second one 30'' to casing 31. They are united together by means of two sleeves 33, 34 to which they are respec-

tively glued. The operation is not modified but the manufacture is rendered easier, each part 30' or 30'' being easily moulded and vulcanized in contact with the members to which it is to be glued.

Fig. 17 shows a mounting in which the upper limiting abutment houses the spring means. The lower connection comprises a transverse bar 35 fixed to the engine assembly, the ends of this bar being passed through rubber blocks 36 fixed within rings 37 carried by the frame 4. Blocks 36 are not circular in cross section, their sides being plane to leave lateral free spaces 38. This connection permits a material oscillation of the engine about a vertical axis owing to the free spaces 38; it also permits transverse oscillations about an horizontal axis in the vicinity of bar 35, as well as the conical oscillation under the action of the rotating resultant of the periodic forces.

The upper limiting abutment may be of the kind shown in Figs. 15 and 16, but it is preferably constructed as shown in Fig. 18. A nose 20 is fixed to the engine and operates with play within a box 27 provided with an inner coating 28 of rubber. Two coil springs 39, adjustable by means of screws 40 act on both sides of nose 20 in a plane transverse with respect to shafts 3. A small block 41 of rubber is disposed within nose 20 at the end of a rod 42 which traverses the same and box 27, and is adjustable by means of a nut 43.

This limiting abutment operates to limit the oscillations of the engine but it also limits the upward displacements thereof, which may become important when blocks 36 are made of soft rubber. Of course the hole 44 for rod 42 must be large enough to permit the oscillations.

Of course the mounting of Fig. 17 could use a connection of the kind shown in Fig. 1, for instance.

In the mounting of Fig. 19 the spring means are in the form of a number of rubber blocks surrounding the engine in a discontinuous ring. These blocks 45 are disposed between brackets 46 projecting from the engine casing 1, and an annular member 47 of the frame. The lower connection may be of any kind, for instance of the type shown in Fig. 1.

Fig. 20 illustrates a modification in which the blocks 45 are disposed radially between two annular members 48 and 49 respectively fixed to the engine and to the frame.

In either case, the blocks act as a number of springs. They support the driving torque exerted by shafts 3 and permit the engine oscillations. No limiting abutment is required with this mounting.

The lower connection may be of the kind shown in Fig. 21, comprising a rubber cushion 50 supporting the weight of the engine, and an annular member 51, also of rubber, surrounding a tail or spindle 52 which terminates the engine assembly. The rubber parts are preferably glued to metal rings or plates as illustrated, which facilitates the construction.

In the above described mountings the engine is vertical and the whole weight thereof is to be supported by the connection, although in the case of Fig. 19 the blocks 45 may support a part of the engine weight. But in some cases the engine has to be disposed at an angle or horizontally. The mounting then remains substantially of the same kind but the springs must support a large portion of the engine weight.

In the example of Fig. 22, the engine is connected to the frame by a block 53 of rubber glued

between two plates 54 and 55 respectively fixed to the frame and to the engine assembly proper. V—V is the axis of the crankshaft and X—X an axis parallel to V—V and passing through the centre of gravity G. F—F indicates the plane of the cylinder axes. The connection is located on X—X, or in the immediate vicinity thereof, at a point intermediate between G and the centre C of the conical oscillation under the action of the periodic forces, as explained in the case of Fig. 1. The engine is moreover supported by lateral springs, the engine casing 1 carrying on each side a bracket 56 traversed by a rod 57 fixed to the frame 4. Two opposed conical springs 58 and 59 are inserted between bracket 56 and the end of rod 57 or the upper face of frame 4. These springs are preferably of the kind described in my said application Serial No. 10,075. Their radial pitch is large enough to permit the transverse displacements of the engine, which differentiates this mounting from those described in my said patent 2,084,080 in which there is no transverse movement of the engine assembly. Of course the hole through bracket 56 for rod 57 must be of a diameter sufficient to permit these transverse displacements. The springs should be disposed in close vicinity of the plane F—F, but owing to practical considerations this is not always possible and in the example illustrated they are located between G and F—F. They thus support the greatest portion of the engine weight.

This mounting also includes a limiting abutment comprising a rubber coated member 60 fixed to the engine and housed with play within a box 61 fixed to the frame. This abutment is substantially disposed on axis X—X.

Figs. 23 and 24 show a modified form of connection comprising a tubular mass of rubber 62 disposed between a spindle 63 fixed to the engine and a sleeve 64 fixed to the frame.

I claim:

1. In combination a frame; an engine assembly comprising an engine proper with cylinders radially disposed about a motor shaft, said engine producing periodic torques tending to oscillate said engine assembly about a varying natural oscillation axis passing through the center of gravity thereof and parallel in average direction to said motor shaft, and said engine also producing periodic forces tending to oscillate said engine assembly conically about a varying natural oscillation center substantially disposed on the average position of said varying natural oscillation axis; driving shafts through which a driving torque is derived from said engine assembly, said driving shafts being supported by said engine assembly transversely of said motor shaft; spring means adapted to maintain said engine assembly on said frame while permitting the conical oscillations thereof and resisting the average driving torque exerted by said driving shafts; and a flexible connection for yieldably retaining said engine assembly with respect to said frame, said connection being arranged to permit conical oscillations of said engine assembly, and said connection being disposed substantially on the average position of said varying natural oscillation axis, at a position intermediate between the center of gravity of said engine assembly and the average position of said varying natural oscillation center.

2. In combination a frame; an engine assembly comprising an engine proper with cylinders radially disposed about a motor shaft, said engine producing periodic torques tending to oscillate said engine assembly about a varying natural

oscillation axis passing through the center of gravity thereof and parallel in average direction to said motor shaft, and said engine also producing periodic forces tending to oscillate said engine assembly conically about a varying natural oscillation center substantially disposed on the average position of said varying natural oscillation axis; driving shafts through which a driving torque is derived from said engine assembly, said driving shafts being supported by said engine assembly transversely of said motor shaft; a flexible connection for yieldably retaining said engine assembly with respect to said frame, said connection being arranged to permit conical oscillations of said engine assembly, and said connection being disposed substantially on the average position of said varying natural oscillation axis, at a position intermediate between the center of gravity of said engine assembly and the average position of said varying natural oscillation center; and two spring systems disposed at each side of said engine assembly in a plane passing through the center of gravity thereof and parallel to said motor shaft and to said driving shafts, said spring systems being located on the other side of the center of gravity of said engine assembly with respect to said connection, and said spring systems being arranged to accommodate the conical oscillations of said engine assembly.

3. In a combination as claimed in claim 2, each spring system comprising two opposed conical springs with a material radial pitch.

4. In a combination as claimed in claim 2, each spring system comprising a spiral spring having its axis perpendicular to the plane containing said two spring systems and having a material radial pitch.

5. In a combination as claimed in claim 2, each spring system comprising in combination a spiral spring having its axis perpendicular to the plane containing said two spring systems and having a material pitch; and cheeks fixed to one of the ends of said spring and enclosing the same, the windings of said spring progressively contacting one of said cheeks as the load increases.

6. In combination a frame; an engine assembly comprising an engine proper with cylinders radially disposed about a motor shaft, said engine producing periodic torques tending to oscillate said engine assembly about a varying natural oscillation axis passing through the center of gravity thereof and parallel in average direction to said motor shaft, and said engine also producing periodic forces tending to oscillate said engine assembly conically about a varying natural oscillation center substantially disposed on the average position of said varying natural oscillation axis; driving shafts through which a driving torque is derived from said engine assembly, said driving shafts being supported by said engine assembly transversely of said motor shaft; a flexible connection for yieldably retaining said engine assembly with respect to said frame, said connection being arranged to permit conical oscillations of said engine assembly, and said connection being disposed substantially on the average position of said varying natural oscillation axis, at a position intermediate between the center of gravity of said engine assembly and the average position of said varying natural oscillation center; and an elastic connection between said engine and frame on the average position of said varying natural oscillation axis at the end of said engine assembly opposed to said flexible connection, said elastic connection being

adapted to form spring means to yieldably maintain said engine on said frame and to resist the average driving torque delivered by said driving shafts, and also to form abutment to limit the abnormal oscillations of said engine assembly with respect to said frame.

7. In a combination as claimed in claim 6, said elastic connection comprising a block of rubber of substantially parallelepipedic shape, said block having a depression at its outer end; means to fix said block in position, said means embodying a cup-shaped member inserted into said depression; and a flaring box enclosing said block of rubber, the extreme end of said block being glued to the bottom of said box.

8. In a combination as claimed in claim 1, said flexible connection embodying a rubber block.

9. In a combination as claimed in claim 1, said flexible connection embodying a rod transversely fixed to said engine assembly; rings fixed to said frame and accommodating with play the ends of said rod; and rubber blocks inserted between said rings and said rod.

10. In a combination as claimed in claim 1, said spring means comprising leaf springs having their central portions fixed to said engine assembly; a finger fixed to said frame; a rubber sleeve on said finger, said rubber sleeve being gripped by one end of said leaf springs; and a forked member fixed to said frame, said member receiving the other end of said leaf springs.

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