July 11, 1939. J. H. S. GARDNER ET AL 2,165,750

FLEXIBLE MOUNTING FOR INTERNAL COMBUSTION ENGINES

Filed July 23, 1937 9 Sheets-Sheet 1

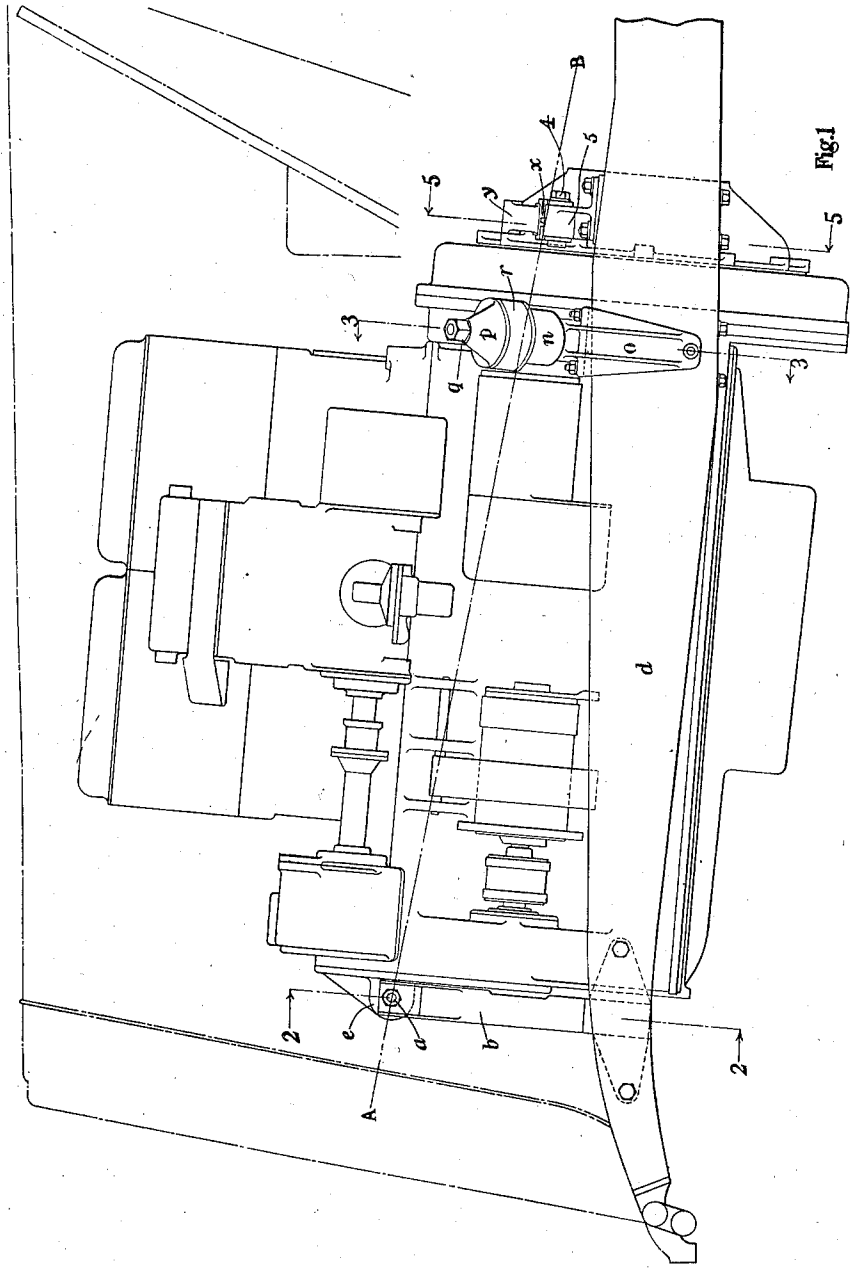


Fig.1

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FLEXIBLE MOUNTING FOR INTERNAL COMBUSTION ENGINES

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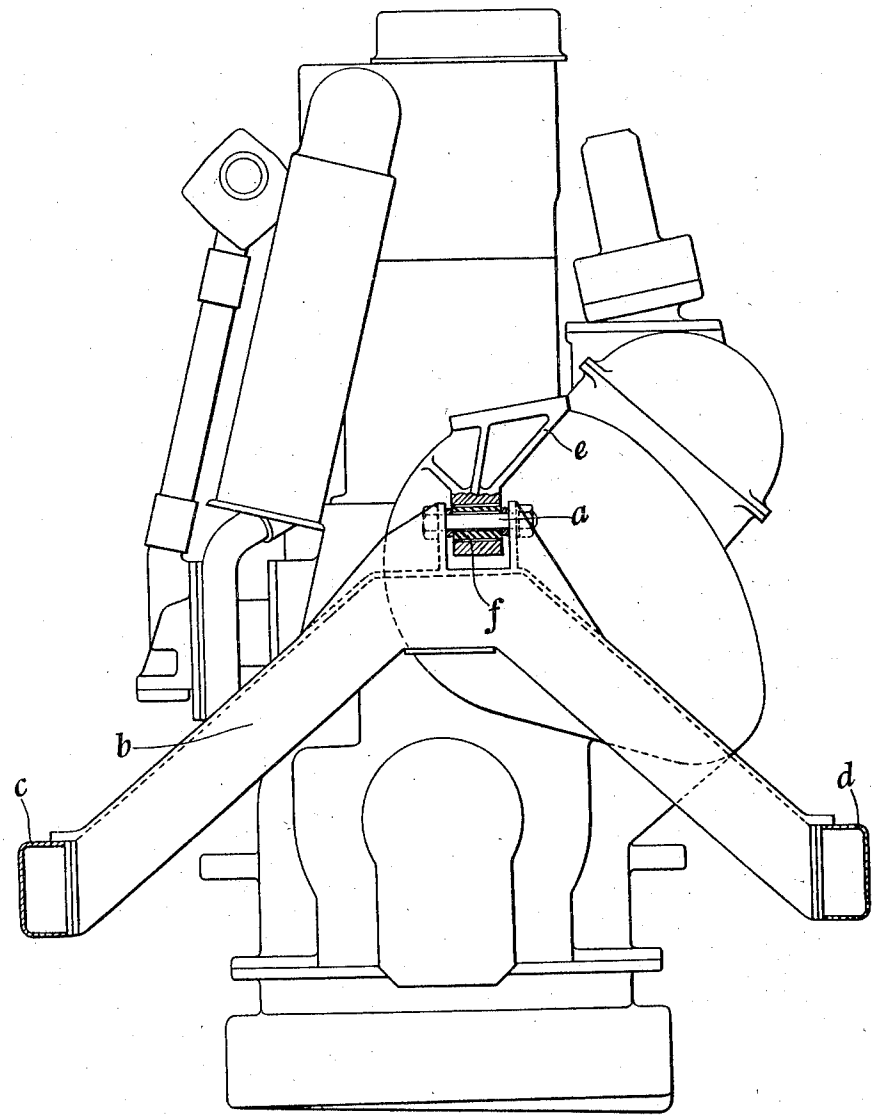


Fig.2

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FLEXIBLE MOUNTING FOR INTERNAL COMBUSTION ENGINES

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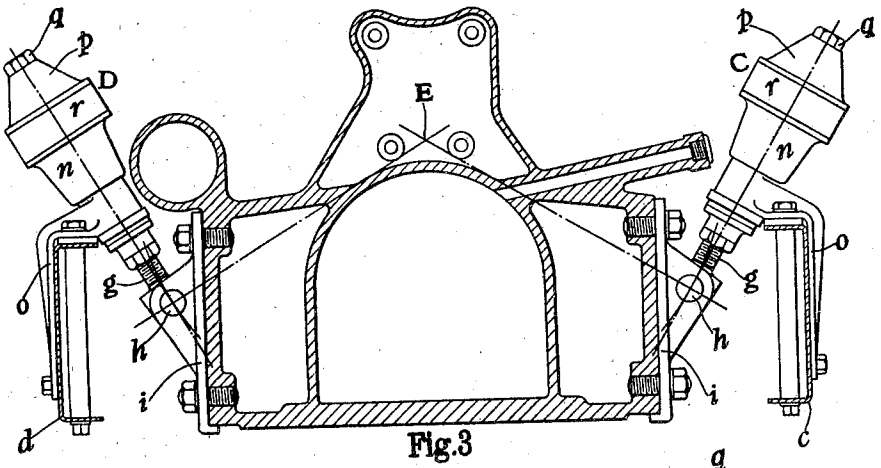


Fig.3

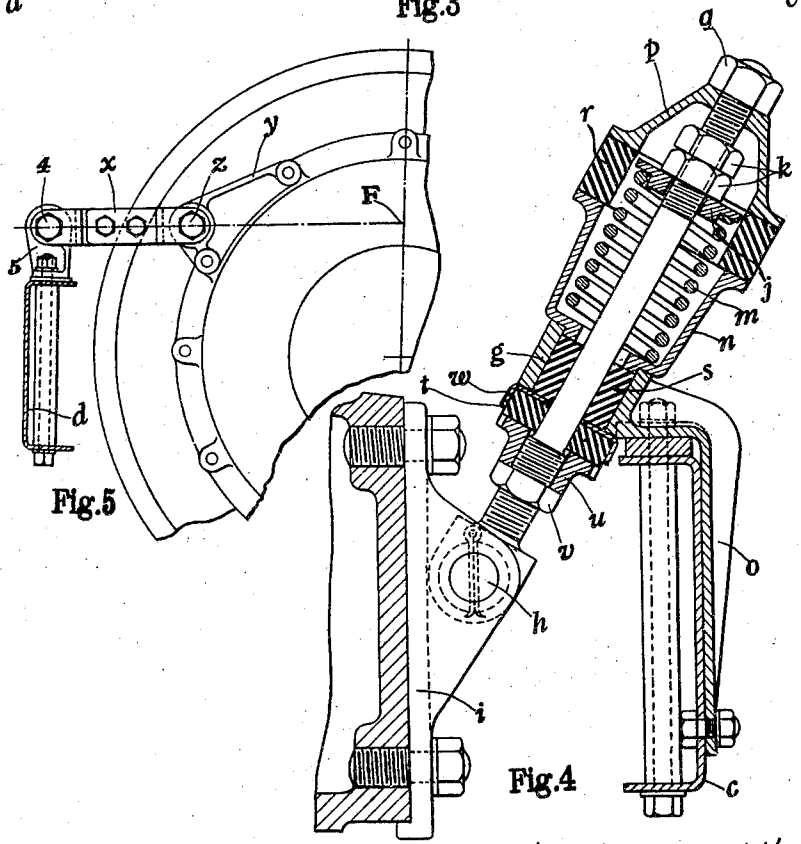


Fig.5

Fig.4

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FLEXIBLE MOUNTING FOR INTERNAL COMBUSTION ENGINES

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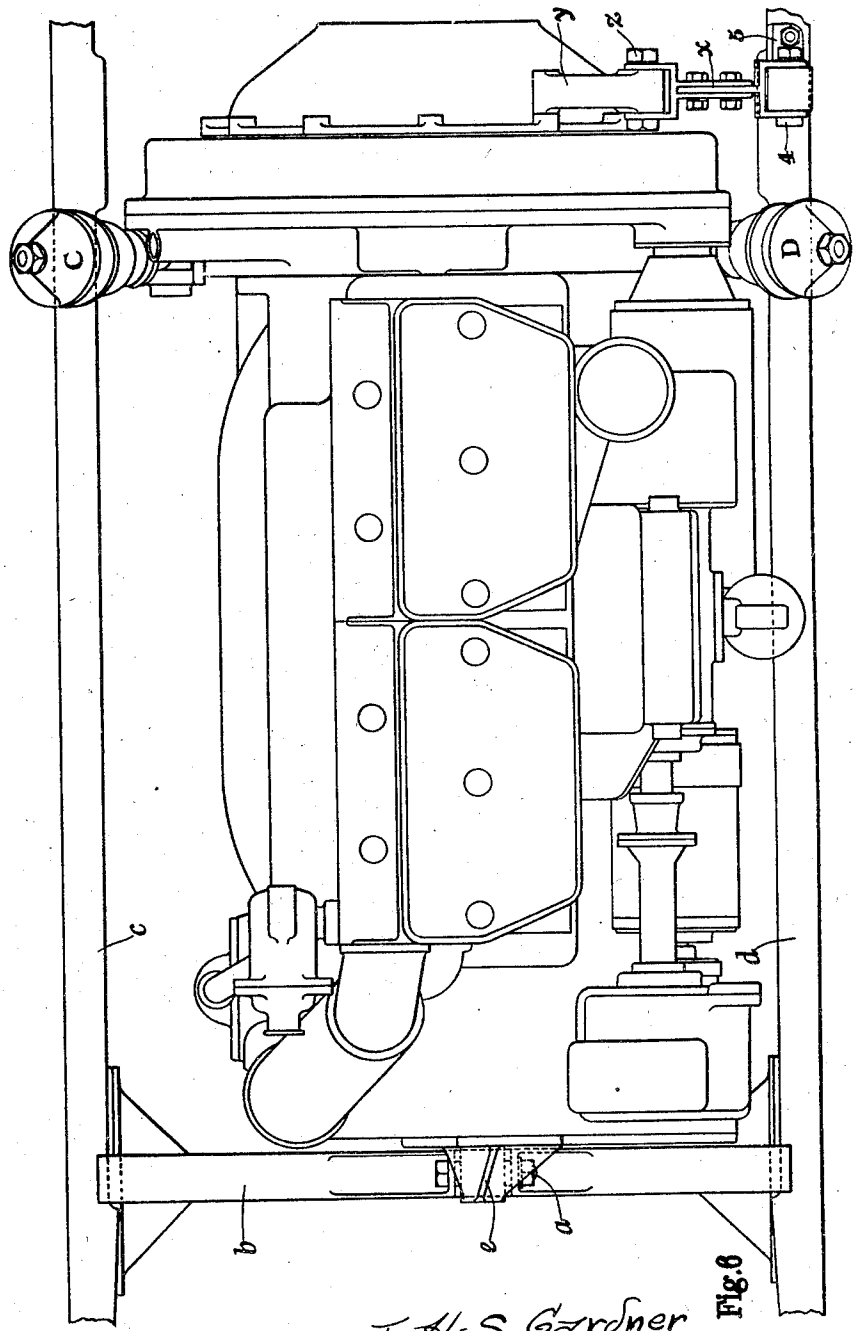


Fig. 6

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FLEXIBLE MOUNTING FOR INTERNAL COMBUSTION ENGINES

Filed July 23, 1937 9 Sheets-Sheet 5

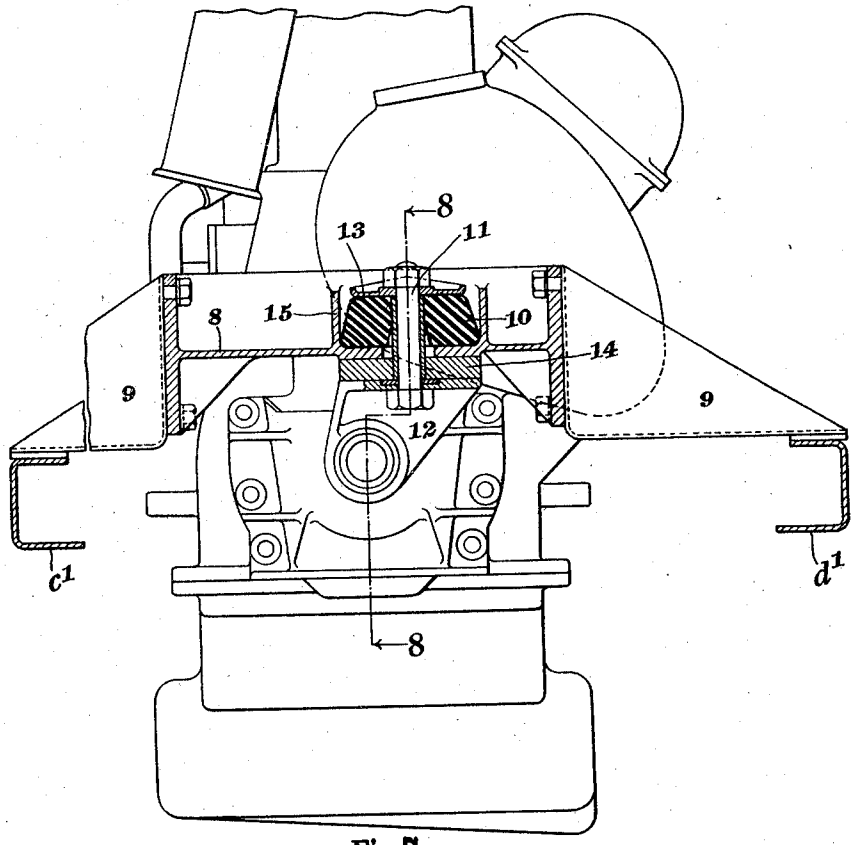


Fig.7

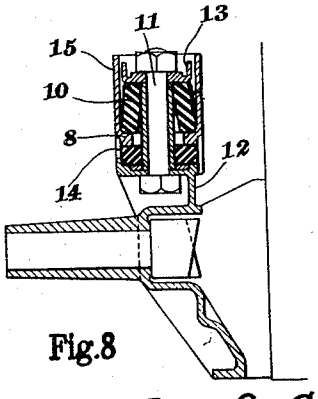


Fig.8

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July 11, 1939. J. H. S. GARDNER ET AL 2,165,750

FLEXIBLE MOUNTING FOR INTERNAL COMBUSTION ENGINES

Filed July 23, 1937 9 Sheets-Sheet 6

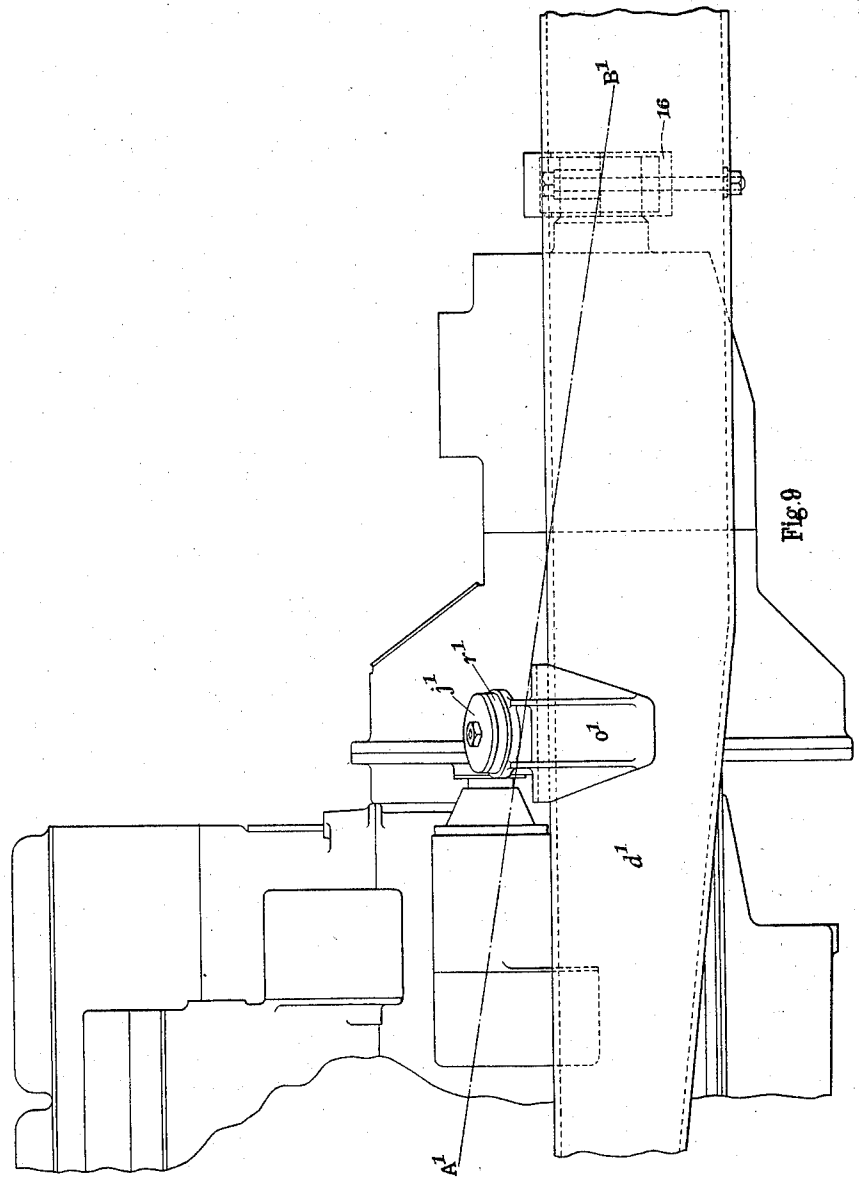


Fig. 9

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July 11, 1939. J. H. S. GARDNER ET AL 2,165,750

FLEXIBLE MOUNTING FOR INTERNAL COMBUSTION ENGINES

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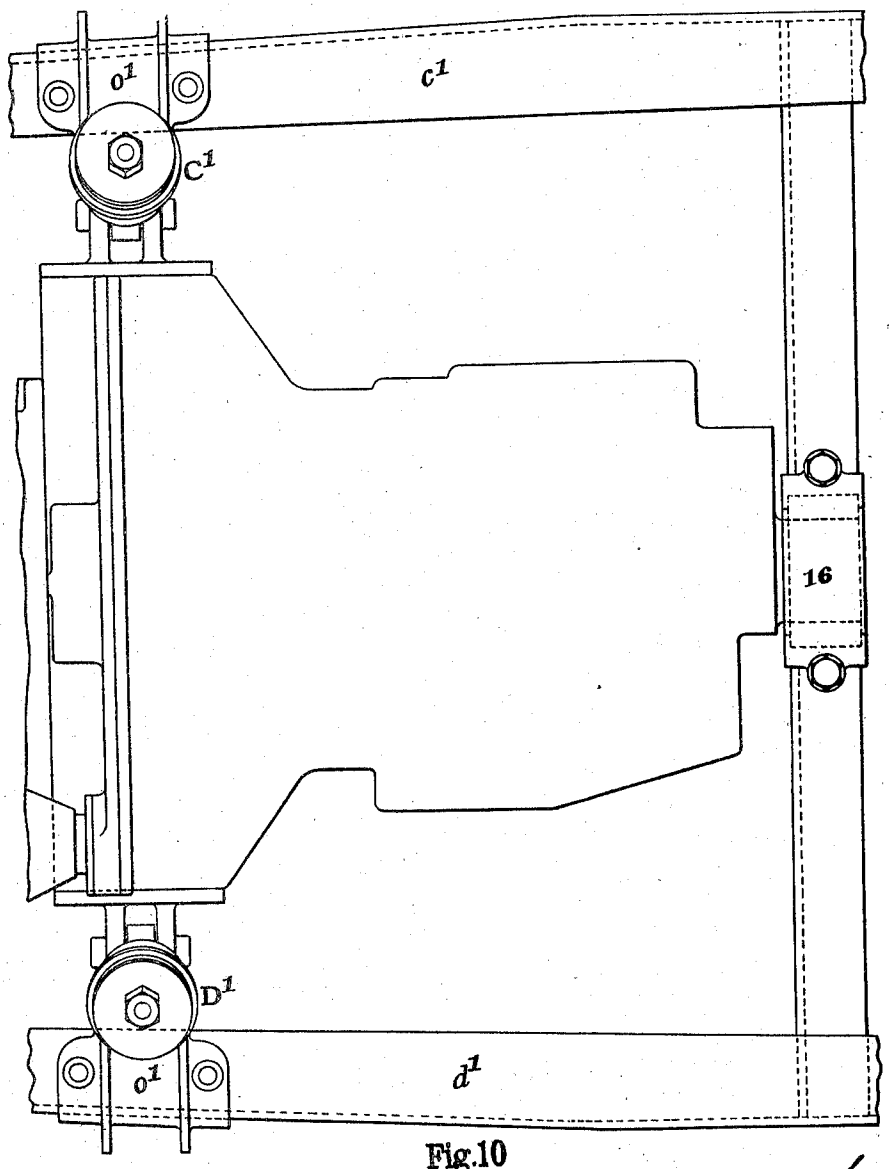


Fig.10

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July 11, 1939. J. H. S. GARDNER ET AL 2,165,750

FLEXIBLE MOUNTING FOR INTERNAL COMBUSTION ENGINES

Filed July 23, 1937 9 Sheets-Sheet 8

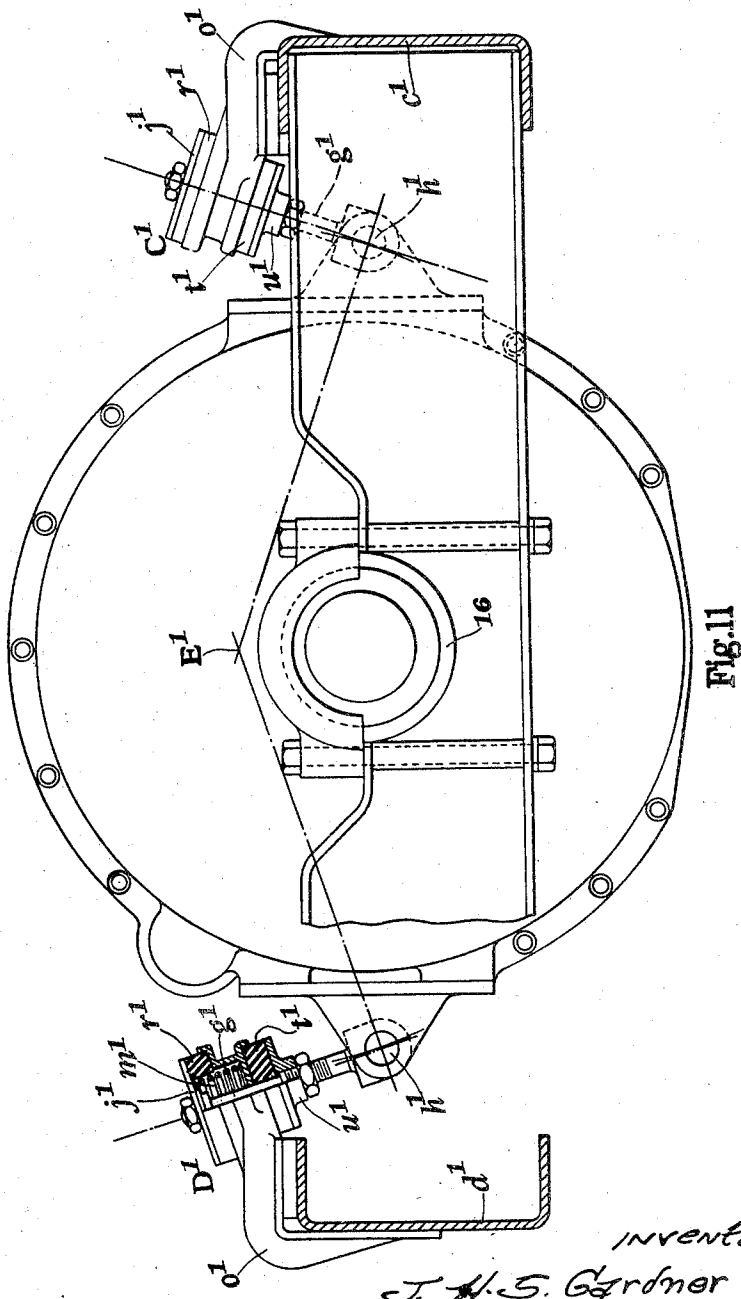


Fig.11

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FLEXIBLE MOUNTING FOR INTERNAL COMBUSTION ENGINES

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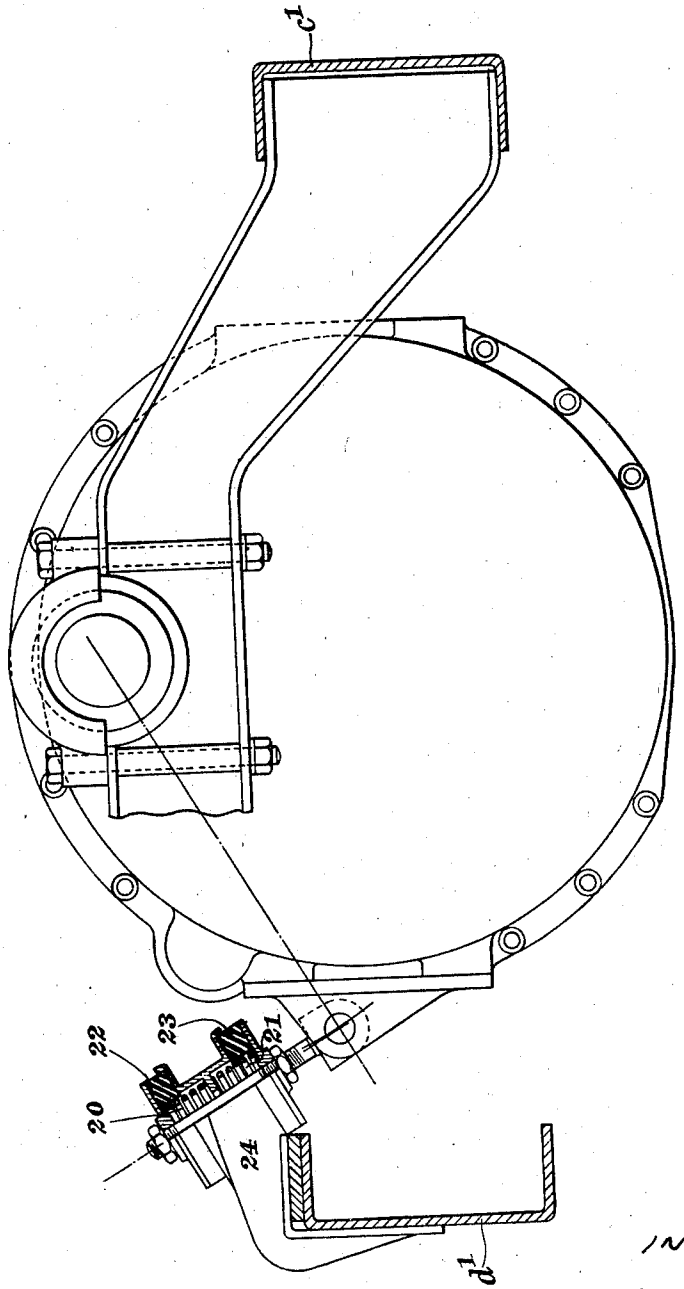


Fig.12

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UNITED STATES PATENT OFFICE

2,165,750

FLEXIBLE MOUNTING FOR INTERNAL COMBUSTION ENGINES

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Application July 23, 1937, Serial No. 155,348
In Great Britain October 16, 1936

3 Claims. (Cl. 248—7)

Internal combustion engines and particularly petrol engines have been suspended in motor vehicle chassis at three points which permit of oscillation of the engine (due to torsional reaction forces) about its natural axis. The movement has usually been allowed for by using rubber buffers in the engine mountings. The arrangements heretofore proposed whilst suitable for use for petrol engines are, however, unsuitable when compression ignition engines come in question, because due to the high pressures occurring in such engines, the magnitude of the forces to be dealt with by the mounting is far in excess of anything to be found in petrol engine practice.

The object of the present invention, is to provide a flexible mounting which permits of almost completely free oscillations of the engine about its natural axis within controlled limits and which is suitable for use for engines of the compression ignition type.

The invention consists in a flexible mounting for an internal combustion engine of the type in which the engine is allowed to turn about its natural axis and is characterised in this that the movements of the engine are permitted by low rate springs which allow sufficient amplitude of movement of the engine having regard to its inertia that the periodic torsional impulses are substantially completely absorbed in producing that movement, in combination with high rate limiting stops to prevent excessive amplitude of movements.

The invention further consists in a flexible mounting of the type specified in which the suspension is at three points, either one at the forward end and two at the rear, or one at the rear and two at the forward end, the suspensory systems at each of the two points at one end of the engine comprising low rate springs and high rate limiting stops.

The invention further consists in a flexible mounting of the type specified in which the suspension is at two points, one at the forward end and one at the rear, with a torque arm or arms upon the engine having its or their movements controlled by low rate springs, with high rate limiting stops to prevent excessive amplitude of movements.

Referring to the accompanying sheets of explanatory drawings:—

Figure 1 is a side elevation of an engine mounted in a vehicle chassis, in one convenient form in accordance with the present invention.

Figure 2 is a front view substantially on the line 2—2 of Figure 1 showing the front support of the engine.

Figure 3 is a sectional view on the line 3—3 of Figure 1.

Figure 4 is a sectional view drawn to a larger scale of one of the flexible engine supports shown in Figure 3.

Figure 5 is a sectional view on the line 5—5 of Figure 1.

Figure 6 is a plan view of Figure 1.

Figure 7 is a view partly in section of the front of an engine having a modified form of mounting supported at a point which is vertically beneath the natural axis of the engine.

Figure 8 is a sectional view on the line 8—8 of Figure 7.

Figure 9 is a side view, Figure 10 a plan view and Figure 11 is a view looking from right to left of Figure 9 showing a modification of the support for the rear end of the engine which in this case has the gear box forming a unitary structure therewith.

Figure 12 is a view similar to Figure 11 but showing a modification suitable for use when the engine and gear box are separate units.

In Figures 1—6, the natural axis of the engine, that is the axis about which the engine tends to revolve due to torque reaction is indicated by the line A B. At the forward end the engine is supported at the natural axis by a pin *a* carried in a cross bracket *b* secured at its ends to the chassis members *c*, *d*. There is a bracket *e* upon the engine which has a rubber bushing *f* therein through which the pin *a* passes.

At the rear end the engine is supported by two flexible mounts C D each of which is disposed substantially tangentially to a circle having the natural axis of the engine in the plane of said mounts, as centre. In Figure 3, E indicates the location of the natural axis of the engine in the plane of the flexible mounts C and D.

Each flexible mount, as shown particularly in Figure 4, comprises a bolt *g* pivotally attached at *h* to the engine frame. The axis of the bolt *g* is tangential to a circle of which the natural axis point E is the centre and the point *h* of pivotal attachment of the bolt to the engine frame *i* is on the circumference.

The bolt *g* has a collar *j* thereon secured in a definite position by the nuts *k* and this collar rests upon the coil spring *m* which constitutes the low rate spring for supporting the engine and permitting movement thereof about its natural axis due to torque reaction. The spring *m* is supported in a part *n* carried by a bracket o

secured to the vehicle chassis member *c*. Upon the upper end of the bolt *g* is a cover piece *p* adjustably held in position on the bolt by a nut *q* and beneath the cover is a rubber ring *r* which constitutes a high rate stop. There is a rubber bushing *s* around the bolt *g* within the bracket *o* and there is a further rubber block *t* between a collar *u* located adjustably on the bolt *g* by the nut *v* and a cup *w* beneath the underside of the bracket *o*. Th rubber block *t* forms a second high rate stop which, with the ring *r*, serve to limit the amplitude of movement of the engine due to (a) high torque reactions under load, (b) synchronism of the sprung mass with the torque reaction when the engine is stopping or starting and (c) shock transmitted from the road.

It is understood that the rate of a spring is the ratio of the load applied thereto to the increase or decrease in its length due to such load. If the load be measured in lbs. and the variation in length due to the load be measured in inches, then we have found that with a compression ignition engine comprising four cylinders in line of the type used in motor vehicles, a low spring rate of about 400 and a high rate spring of the order of 1500 or more can be advantageously employed, but obviously these rates are governed by inter alia, the ratio of the magnitude of the torque reaction forces to the inertia of the engine, provided always that the engine must be allowed sufficient amplitude of relatively free movement having regard to its inertia, that the periodic torsional impulses are substantially completely absorbed in producing that movement.

Lateral movement of the rear of the engine is restrained by the link *x* which is directed radially or substantially radially towards the natural axis of the engine in the plane of the link. In Figure 5, the location of the natural axis of the engine in the plane of the link *x* is at F. The link is connected to the bracket *y* on the engine by a rubber bushed pin or bolt *z* and it is similarly attached by a rubber bushed pin or bolt **4** to a bracket **5** secured to the vehicle chassis member *d*.

It will be seen that with the arrangement illustrated in Figures 1–6, the dead weight at the front of the engine is carried by the pin *a* located at the natural axis of the engine. The rubber bushing *f* gives the necessary degree of freedom for movement about the natural axis of the engine at the front end. At the rear end, the engine weight is carried by the low rate springs *m* through bolts *g* which have their axes tangential or substantially tangential to a circle having the natural axis of the engine, in a plane containing said bolts, as its centre and the points where the bolts are connected to the engine frame on its circumference. The low rate springs permit of torque reactions at idling speed being absorbed by the inertia of the engine oscillating about its natural axis. Owing to the low rate, the deflections of the springs due to engine oscillation impose only small variations of loading upon the chassis. The rubber buffers *t* and rings *r* deal with any tendency to excessive movements of the engine due to high torque reactions or to synchronism of the sprung mass with the torque reaction of the engine when the engine is stopping or starting or accelerating from idling speed. The rubber blocks *r* and *t* also deal with the movements of the engine due to road bounce when the vehicle is travelling over rough or uneven surfaces. The link *x* prevents lateral or sideways movement of the engine in the chassis and the forward support by the pin *a* prevents longitudinal movement.

Where it is not possible to carry the forward end of the engine upon a support located at the natural axis of the engine, the arrangement shown in Figures 7 and 8 may be adopted. This consists of a frame **8** secured by brackets **9** to the chassis members c^1 and d^1 and having a cup-like recess **15** to receive a rubber block **10** through which passes a bolt **11** secured to a bracket **12** rigid with the engine frame at a point vertically below the natural axis of the engine at its forward end. A plate **13** upon the upper end of the bolt **11** rides upon the rubber block **10** which is a close fit in the cup **15** in a fore and aft direction as shown in Figure 8 but is tapered considerably in the lateral direction of the engine as shown in Figure 7 to permit of lateral movements (which cause shear stresses in the rubber) substantially in a direction tangential to a circle with the natural axis of the engine in the plane of the bolt **11** as centre. A rubber block **14** beneath the bracket **8** acts as a high rate (spring or buffer) stop to limit lifting movements of the engine relatively to the chassis due to road shocks or the like.

In the modified arrangement shown in Figures 9, 10 and 11 the rear end of the engine and gear box unit is supported in a rubber bushed ring **16** which is co-axial with the natural axis of the engine at that point, the said natural axis being indicated by the line A^1 B^1 in Figure 9. Turning of the engine about the said natural axis is controlled by the two resilient or flexible stops C^1 D^1 which function similarly to the mounts C D of Figures 1–6. One of the resilient or flexible stops is shown partly in section and partly in elevation at the left hand side of Figure 11. It comprises a bolt g^1 connected to the engine frame at h^1, a collar j^1 upon the bolt being adapted to rest upon the low rate spring m^1 until the latter has been compressed beyond a predetermined extent when it comes on to the rubber block r^1 carried by the bracket o^1 which is secured to the vehicle chassis member c^1 or d^1. There is a rubber buffer block t^1 beneath the bracket o^1 which cushions upward movements of the collar u^1 secured upon the bolt g^1. The axes of the bolts g^1 are substantially tangential to a circle which have the points h^1 on its circumference and its centre at the natural axis of the engine in the plane of the bolts g^1. In Figure 11, the natural axis in the plane of the bolts g^1 is at E^1.

It will be understood that in Figures 9–11 the dead weight of the engine is carried by the supports of the engine in the vehicle chassis at the natural axis of the engine at its front and rear ends and the units C^1 and D^1 are concerned only with movements of the engine about such axis due to torque reaction, road bounce and like causes.

The Figure 12 construction is similar to the Figure 11 construction with regard to the mounting of the engine at its natural axis in the vehicle chassis but the torque reaction cushioning device is double acting so that only one need be used. Its construction will be clear after a consideration of the construction shown in Figure 11. There are low rate springs **20** and **21** and high rate limiting stops **22** and **23** at the opposite sides of the bracket **24** secured to the chassis member d^1.

In the arrangements shown in Figures 9 to 12

the forward end of the engine may be mounted as shown in Figure 2 or in Figures 7 and 8.

It will be appreciated that the torque cushioning systems illustrated in Figures 9 to 12 may be located at any convenient point in the length of the engine. The suspensory system shown for the rear of the engine in Figures 1–6 may be applied to the front of the engine and the rear of the latter be mounted as shown in Figures 9–12.

We wish it to be understood that our invention can be applied to the mounting of engines for all services and is not limited to engines in vehicles.

It will be understood that in all cases the low rate springs act independently of the high rate limiting stops until the amplitude of engine movements exceeds a predetermined maximum, when such stops come into action. When, for example, the static load of the engine is being supported by the low rate springs *m* in the example illustrated in Figures 1–6, the clearance between the part *p* and the high rate stop *r* will be of the order of 0.02'' and so cannot be represented with clarity in the drawings. A clearance under the same conditions will exist between the cup *w* containing the rubber buffer *t* and the underside of the bracket *o* through which the bolt *g* extends.

We claim:

1. An engine mounting for a multi-cylinder internal combustion engine, comprising at least two bolts each pivotally secured to the engine, and disposed substantially tangential to a circle through the point of pivotal attachment of the bolt to the engine and having its centre on the natural axis of the engine, a collar upon said bolt axially adjustable therealong, a fixed point of support, a low rate compression coil spring surrounding said bolt and acting between said point of support and said collar, a part axially adjustable along said bolt and a high rate rubber buffer in fixed position so disposed as to be contacted by said part when said coil spring has been compressed beyond a predetermined amount.

2. An engine mounting as claimed in claim 1, comprising also a further part axially adjustable along said bolt and a further high rate rubber buffer in fixed position so disposed as to be contacted by said further part on movement of said bolt in reverse direction from that which compresses the coil spring.

3. An engine mounting for a multi-cylinder engine consisting of means to support the engine at front and rear ends comprising at least two parts each pivotally connected to the engine and disposed substantially tangential to a circle through the point of pivotal attachment of the part to the engine and having its centre on the natural axis of the engine, a fixed point of support, a low rate spring acting between the said part and said fixed point of support having sufficient amplitude of movement to absorb the usual periodic torsional impulses of the engine, and a high rate limiting stop likewise acting on the pivoted part and arranged to resist engine movements of excessive amplitude, all said points of support being located at a higher level than the associated points of pivotal attachment of the parts to the engine.

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