United States Patent

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[54] **ELASTOMERICALLY MOUNTED CHAIN SAW**
16 Claims, 6 Drawing Figs.

[52] **U.S. Cl.** **143/32,** 173/162, 92/161
[51] **Int. Cl.** **B27b 17/00**
[50] **Field of Search** 143/32; 92/161; 173/162

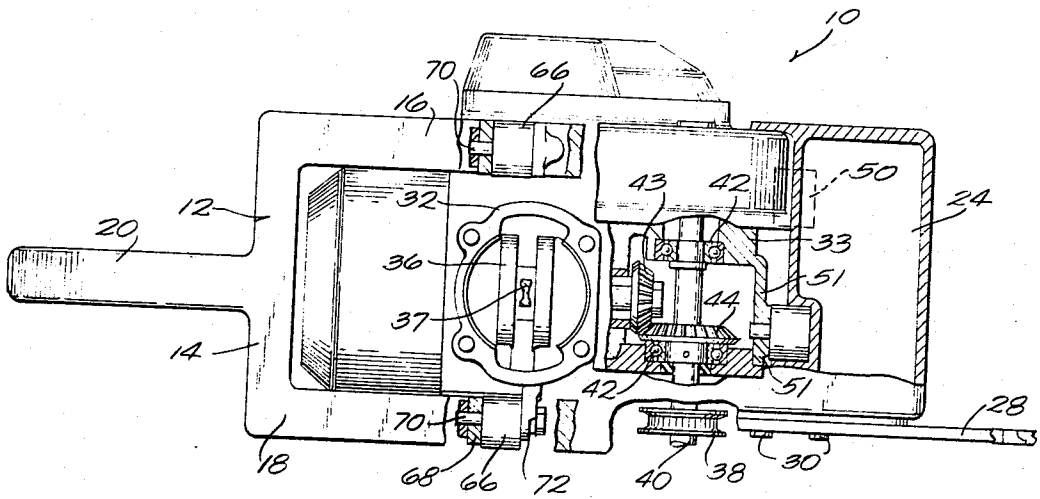
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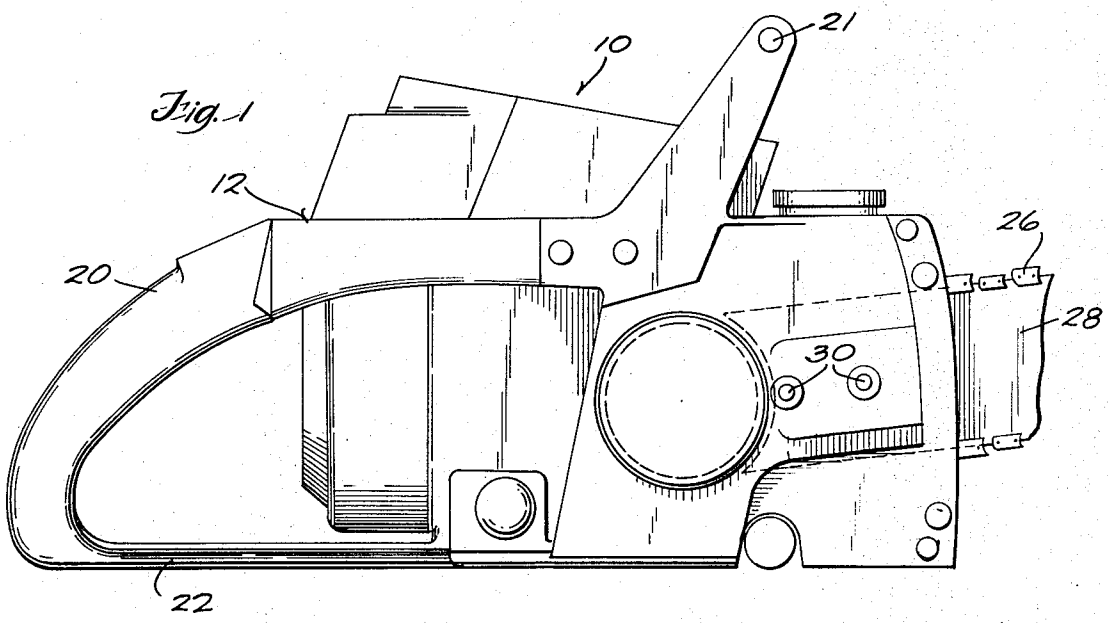
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ABSTRACT: Disclosed herein is a chain saw in which the upper and rear handles, the gas tank and the cutter bar are rigidly secured to a frame to form a frame assembly. The engine is mounted relative to the frame assembly so that the crankshaft is parallel to the cutter bar and the piston reciprocates about a generally vertical axis when the saw is in an upright horizontal position. A sprocket shaft for driving a cutting chain is rotatably supported by a portion of the engine block at right angles to the crankshaft. The engine is mounted to the frame assembly by elastomeric engine mounts which have a low spring rate in the direction of shear and a high rate in the direction of compression.



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Fig. 1



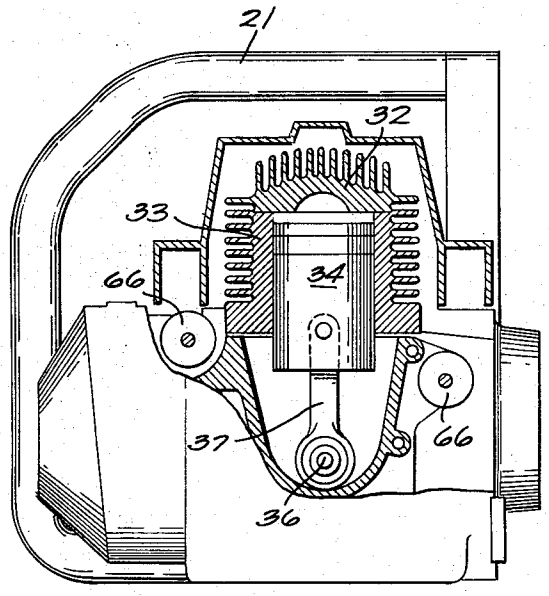


Fig. 2

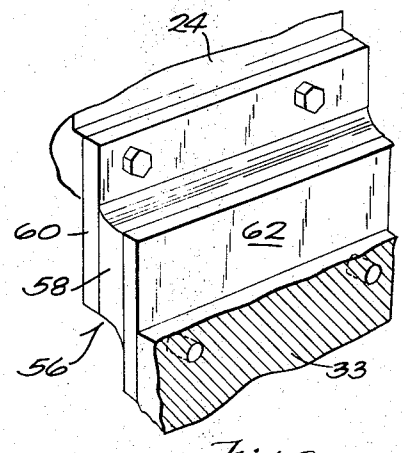
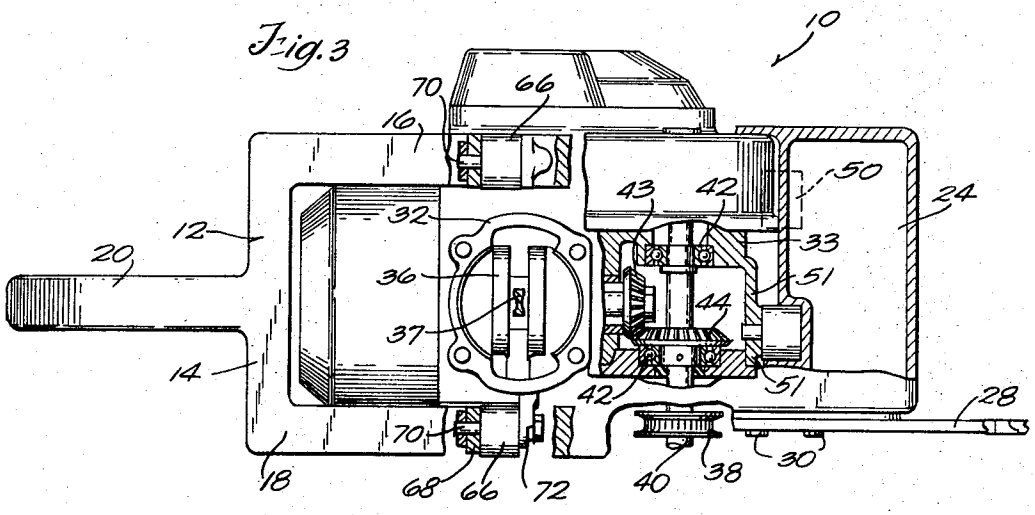


Fig. 6

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Fig. 3



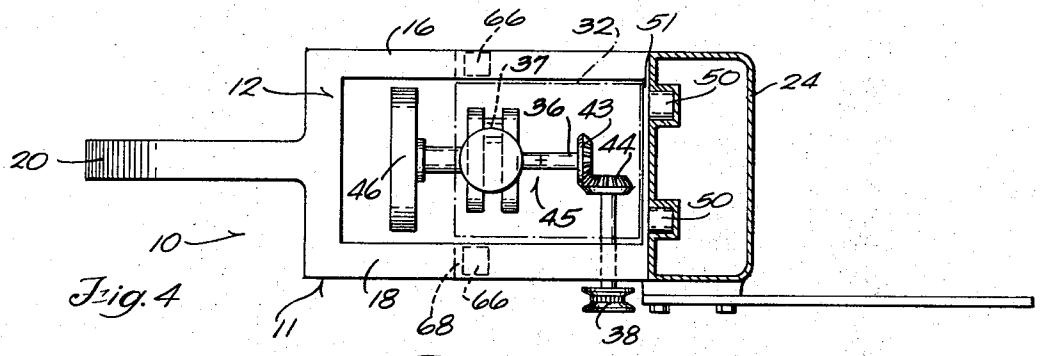


Fig. 4

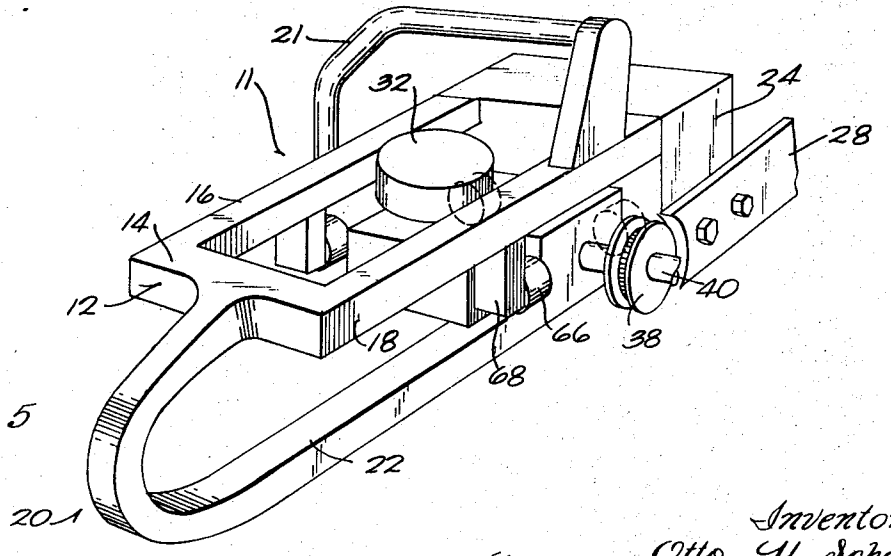


Fig. 5

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ELASTOMERICALLY MOUNTED CHAIN SAW

BACKGROUND OF INVENTION

It is known to isolate a chain saw engine from the handles by rubber mounts. In mounting arrangements of this nature and in particular where the cutter bar is connected directly to the engine block, the mounts must be made soft to provide effective isolation because of the low mass of the handles relative to the engine and saw bar. As a result, any loading or prying action applied on the saw bar during the cutting operation, as for instance, to remove a pinched bar, must pass through the soft mounts, resulting in loss of control and loss of prying force.

SUMMARY OF INVENTION

The invention provides a chain saw comprising an engine which is resiliently mounted on a frame, a shaft carrying a sprocket which is supported independently of the frame by bearings on the engine, a cutter bar mounted from the frame, and a saw chain trained around the sprocket and the cutter bar. More particularly, the invention provides a chain saw in which the cutter bar handles and gas tank are secured to a frame to form an integrated frame assembly. Relative motion between the sprocket and the frame assembly is minimized by an engine mounting arrangement wherein the engine piston travels in a vertical plane and at right angles to the direction of chain pull when the chain saw is in an upright horizontal position. More specifically, the plane of the shaking force incident to engine operation is vertical and at right angles to the chain pull, when the saw is in an upright position with the piston reciprocating in a vertical direction and the direction of chain pull is horizontal. The alignment of the engine in this manner is afforded by the use of a right angle drive connecting the engine crankshaft which is parallel to the cutter bar to a sprocket shaft which is at right angles to the cutter bar, and which is rotatably supported by a portion of the engine block.

Such arrangement permits the use of engine mounts connecting the engine to the frame assembly which have a low rate in the direction of shear which is also parallel to the plane of the shaking force. The use of soft mounts effectively isolates engine vibration from the handles and cutter bar.

The engine mounts have a relatively high rate in the direction of compression to minimize, during cutting, any sprocket shaft displacement which could cause misalignment or slack in the chain between the sprocket and cutter bar.

Vibration in the forward engine mounts and vibration in the frame assembly is further minimized by locating the shaking force of the engine and distributing the mass of the engine so that the shaking force of the engine is at the approximate center of percussion of the engine mass with respect to the forward engine mounts. Because of the proximity of the forward mounts to the sprocket axis and as a consequence of the yieldability of the forward mounts in the direction of shear and in response to engine vibration, during operation, the engine tends to pivot about the sprocket axis rather than to transfer vibration or impulses to the frame assembly.

In addition, the center of gravity of the engine is located forwardly of the plane of the shaking force to minimize the amplitude of the engine vibrations in the forward mounts and sprocket shaft.

Rear engine mounts are provided between the engine and frame assembly on opposite sides of the piston and near the plane of the shaking force, *i.e.*, a plane at right angles to the crankshaft through the center line of the piston and the cylinder. The rear mounts have a low rate in shear to afford pivotal movement of the engine about the forward mounts.

Because the chain saw bar is part of the rigid frame assembly rather than being secured to the engine, control of the cutter bar is not lost during prying action or movement to remove a pinched bar.

Further objects and advantages of the invention will become apparent from the following description and accompanying drawings.

DRAWINGS

FIG. 1 is a side elevational view of a chain saw in accordance with the invention.

FIG. 2 is a rear or end view, in fragmentary section, of the chain saw shown in FIG. 1.

FIG. 3 is a plan view, in fragmentary section, of the chain saw shown in FIG. 1.

FIG. 4 is a diagrammatic plan view of the chain saw disclosed in FIG. 1.

FIG. 5 is a diagrammatic perspective view of the chain saw disclosed in FIG. 1.

FIG. 6 is an alternate construction for the forward mount between the engine and frame.

DETAILED DESCRIPTION

The invention relates to a chain saw in which the front and rear handles, the cutter bar and gas tank are secured to a frame to form an integrated frame assembly. The mass distribution of the engine and the location of the engine mounts are arranged relative to the frame assembly to obtain maximum vibration isolation of the engine from the frame assembly.

More specifically and referring to the drawings, a chain saw **10** embodying the invention is provided with a frame assembly **11** which includes a frame **12** (see FIGS. **4** and **5**). The frame **12** includes a U-shaped portion **14** having side legs **16** and **18**. The frame **12** also includes a rear handle portion **20**, upper handle portion **21** and a lower frame portion **22**. A gas tank **24** is connected to the forward end of the side legs **16** and **18** to form a forward portion of the frame assembly **11**.

Referring to FIG. **1**, a cutting chain **26** is supported by a cutter bar **28** (see FIG. **5**) which is generally parallel to the side legs **16** and **18** of the frame **12**. The cutter bar **28** is bolted or otherwise rigidly secured to the frame **12** by bolts **30** and forms an integral part of the frame assembly **11**.

The cutting chain **26** is driven (see FIG. **2**) by an engine **32** having an engine block **33** and a piston **34** which reciprocates about a generally vertical axis when the chain saw is in the upright position of FIGS. **1** and **2**. The piston **34** is connected to the crank **37** of a crankshaft **36** which is generally parallel to the frame side legs **16** and **18** and the cutter bar **28** and which extends fore and aft of the chain saw **10** and is in a horizontal position when the chain saw is in its upright position illustrated in FIGS. **1** and **2**.

Power is supplied to the chain **26** (see FIG. **3**) by a sprocket **38** located at one end of a sprocket shaft **40** which is rotatably supported free of the frame assembly **11** by bearings **42** mounted in a portion of the engine block **33** for rotation about an axis perpendicular to the crankshaft **36** and the cutter bar **28**. Means are provided for drivingly connecting the sprocket shaft **40** to the crankshaft **36**. In the disclosed construction, the means comprises a bevel gear **43** at one end of the crankshaft which meshes with a bevel gear **44** on the sprocket shaft. Thus, the engine block and right angle drive is a unitary structure and is supported by the frame assembly **11** as hereinafter described. The use of a right angle drive with the piston **34** reciprocating in a vertical plane when the chain saw **10** is in the upright position shown in FIGS. **1** and **2** permits the use of mounts which have a low rate in the plane of engine vibration as hereinafter described in detail.

In accordance with the invention, the mass of the engine **32** is distributed so that the shaking force incident to engine operation, *i.e.*, the force caused by reciprocating movement of the piston **34** and the rotary motion of the crank **37**, is located at the center of percussion of the engine mass in relation to the forward mounts of the engine to thus minimize vibration in the frame assembly **11** and thereby also to minimize vibration in the forward engine mounts.

It is well known that if a blow strikes a pivoted or pendulum suspended body or the body receives an impulse at a certain point spaced from the pivotal axis, the impulse will cause only

pivotal movement of the body about the pivotal axis rather than translatory motion or vibration of the entire body. The point at which the impulse or blow must strike the body to cause only pivotal movement of the body about its pivotal axis with no impulse being received at the pivotal axis is called the center of percussion. The location of the center of percussion relative to the pivotal axis can be determined by the equation or law of physics $L = I/ml$ wherein L = the distance of the center of percussion from the pivotal axis O, I = the moment of inertia of the body about the pivotal axis O, m = the mass of the body and l = the distance between the center of mass of the body and the pivotal axis O. The derivation of this equation can be found in the text "Principles of Physics" by Sears, Vol. I, pp. 275, 276, published in 1947 by Addison, Wesley Press, Inc. Additional background of the principles involved is set forth in the text " Mechanics" by Lymon, published in 1953 by Addison-Wesley Publishing Company, Inc.

The location of the plane of the shaking force of the engine **32** at or approximately at the center of percusion of the engine mass and at a distance L from the pivotal axis of the engine mass, *i.e.*, the forward engine mount, to prevent or minimize vibrations or impulses from being received at the forward engine mount, can be determined mathematically by the above law of physics or can be determined empirically. The center of mass **45** of the engine can be varied by moving the flywheel **46** fore or aft on the crankshaft **36**.

The distribution of the engine mass so that the center of gravity is forward of the shaking force reduces the amplitude of the engine vibrations in the sprocket shaft and forward mounts.

In accordance with the invention, means are provided for pivotally mounting the engine to the frame to afford a pivotal axis for oscillatory movement of the engine **32** in response to shaking forces incident to engine operation.

In the construction disclosed in FIGS. **3**, **4** and **5** the means comprises two forward mounts **50** composed of an elastomeric substance such as rubber. The mounts **50** are located between and secured to the forward part **51** of the engine block **33** and the gas tank **24**. Threaded studs (not shown) extending from the mounts can be employed to secure the mounts **50** in place. The mounts have a relatively low rate in shear, *i.e.*, are soft in a vertical direction, to yieldably afford a pivotal axis transverse to the cutter bar for osicllatory or pivotal movement of the engine. The forward mounts **50** desirably have a high rate in the direction of compression, which direction is also the direction of chain pull so as to avoid misalignment of the sprocket **38** and the chain saw bar **28** due to chain pull during the cutting operation, but at the same time, yieldably afford limited translatory movement of the engine in the direction of chain pull. A typical mount **50** can have a shear rate or lateral spring rate such that a 240 pound force will deflect the mounts 1 inch, and a compression rate of five times that value or 1,200 pounds per inch. A single forward mount can be employed between the forward part of the engine block **33** and the gas tank **24** to obtain some of the advantages of the invention.

An alternate construction for the forward mounts is shown in FIG. **6**. In this construction, the forward mount comprises an elastomeric hinge **56** which has an elongate portion of elastomeric material **58** sandwiched between two plates **60** and **62**. The elastomeric material is bonded to the inner surface of the plates **60** and **62**. The plate **60** is bolted to the gas tank and the plate **62** is bolted to the engine. The hinge **56** has a relatively high rate of deflection in compression in the direction of the cutter bar and is yieldable in the direction of shear, *i.e.*, in a vertical direction when the engine is located as shown in FIG. **1**.

It is within the purview of the invention to utilize either the forward mounts **50** or the sprocket axis as the pivotal axis of the engine mass, with the plane of the shaking force located at a distance L from either the forward mounts **50** or at a distance L from the sprocket axis.

The invention also includes means for yieldably mounting the engine at the plane of the shaking force to the frame assembly **11**. The means comprises two rear elastomeric mounts **66** which have a low rate in the direction of shear, *i.e.*, a vertical plane when the chain saw **10** is in an upright position as shown in FIG. **1**, to afford vibration isolation from the frame and a high rate in compression which is the horizontal direction of the chain pull when the chain saw is in this position. The mounts **66** can have a shear rate equal to the forward mounts so that a 240 pound force will deflect the mounts 1 inch.

The mounts **66** are located between depending frame members or brackets **68** and the engine block. The mounts **66** may be secured in this position by bolts **70**, which, as shown in FIG. **3**, extend through the depending bracket **68** and mounting lugs **72** on the block. To provide balance and stability of the engine block relative to the frame, the mounts are aligned so that a plane connecting the centers of the rear mounts **66** will intersect the center of gravity or center of mass **45** of the engine block.

In operation of the chain saw **10** of the invention, the forward mounts **50** readily yield in shear to isolate engine vibrations from the frame assembly **11**.

Various of the features of the invention are set forth in the following claims.

I claim:

1. A chain saw comprising a frame, an engine having reciprocating parts providing a shaking force incident to engine operation, a cutter bar mounted on said frame independently of said engine, a sprocket shaft supported by said engine independently of said frame, a chain sprocket on said shaft, a cutting chain trained around said sprocket and around said cutter bar, and means for pivotally mounting said engine to said frame at a location spaced from the center of engine mass remote from said reciprocating parts whereby said engine is oscillatable about said pivotal mounting means in response to shaking forces.

2. A chain saw in accordance with claim **1** wherein said engine is arranged with respect to said means pivotally mounting said engine so that the distance L from the plane of the shaking force to the pivotal axis of said engine mounting means is governed by the law of physics $L = I/ml$ where I is the moment of inertia of the engine mass about the pivotal axis, m is the mass of the body and l is the distance between the center of mass of the engine and the pivotal axis.

3. A chain saw in accordance with claim **1** wherein said means pivotally mounting said engine to said frame comprises an elastomeric mount which has a low rate in the direction of shear and comparatively high rate in the direction of compression.

4. A chain saw in accordance with claim **1** wherein said means pivotally mounting said engine comprises a hinge having an inner layer of elastomeric material sandwiched between two mounting plates, one of said mounting plates being secured to said engine and the other of said mounting plates being secured to said frame.

5. A chain saw in accordance with claim **1** including means for yieldably mounting the engine to said frame adjacent to the plane of the shaking force.

6. A chain saw in accordance with claim **5** wherein said engine has mounting lugs located adjacent to the plane of the shaking force and said frame has brackets, and elastomeric mounts interposed between said lugs and said brackets.

7. The device of claim **6** wherein a plane connecting the centers of said mounts intersects the center of mass of said engine.

8. A chain saw comprising a frame, a cutting chain, a cutter bar for supporting said cutting chain, said cutting bar being secured to said frame, an engine having a piston which reciprocates at right angles to the direction of pull of said cutting chain during cutting action, said engine having a crankshaft extending parallel to said cutter bar, a sprocket shaft at right angles to said crankshaft, means on said engine

for rotatably supporting said sprocket shaft, means for drivingly connecting said crankshaft to said sprocket shaft, and means for mounting a part of said engine to said frame, said means for mounting a part of said engine to said frame being yieldable in a direction parallel to the direction of travel of said piston, and said last mentioned means being less yieldable in the direction of chain pull than in the direction of travel of the piston.

9. The device of claim 8 wherein said means for mounting a part of said engine to said frame comprises an elastomeric mount located between the forward part of said engine and said frame, said mount having a compression rate greater than the shear rate.

10. The chain saw of claim 8 including means for yieldably mounting said engine to said frame, said means being located between said engine and said frame adjacent the piston.

11. The chain saw of claim 8 wherein said means for rotatably supporting said sprocket shaft comprises bearings supported by a portion of said engine.

12. A chain saw comprising a frame assembly including a frame having a U-shaped portion with side legs, a front handle connected to said frame, a rear handle connected to said frame, a gas tank secured to the forward end of said side legs, a cutter bar secured to said frame, a cutting chain movably supported by said cutter bar, with the direction of chain pull during operation being at right angles to the plane of reciprocation of said piston, a sprocket shaft, an engine rotatably supporting said sprocket shaft and having a piston which reciprocates in a plane perpendicular to said sprocket shaft, and means for mounting a part of said engine to said frame assembly, said means being readily yieldable in a direction parallel to the plane of reciprocation of said piston and less yieldable in the direction of chain pull as compared to the direction parallel to the plane of piston reciprocation.

13. A chain saw in accordance with claim 12 wherein said means for mounting a part of said engine to said frame assembly comprises elastomeric mounts located between the forward portion of said engine and said gas tank and including means for yieldably mounting said engine to said frame assembly, said means being located adjacent said piston and between said engine and said frame.

14. A chain saw comprising a frame, a cutting chain, a cutter bar supporting said cutting chain, said cutter bar being secured to said frame, an engine having a piston which reciprocates at right angles to the direction of pull of said cutting chain during cutting action, a sprocket shaft supported by said engine independently of said frame, a sprocket on said shaft and around which said chain is trained, and resilient means for mounting said engine from said frame, said engine mounting means being located such that the center of mass of said engine is located intermediate said piston and said engine mounting means.

15. A saw chain in accordance with claim 14 wherein said engine mounting means is yieldable in the direction parallel to the direction of travel of said piston and wherein said engine mounting means is less yieldable in the direction of chain pull as compared to the direction parallel to the direction of piston travel.

16. A chain saw comprising a frame, an engine, means resiliently mounting said engine on said frame, a cutter bar mounted on said frame, a sprocket shaft supported independently of said frame by bearings on said engine, a sprocket on said shaft, and a saw chain trained around said sprocket and said bar.