United States Patent [19]

Dillon

[11] **3,889,763**

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[54] **VIBRATION ISOLATION HANDLE FOR PORTABLE CHAIN SAW OR THE LIKE**

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[73] Assignee: **Skil Corporation**, Chicago, Ill.

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[52] **U.S. Cl.** **173/162**; 30/381

[51] **Int. Cl.** **B27b 17/02**

[58] **Field of Search** ..... 30/381, 383, 382, 384, 30/387; 173/162; 16/116 R

[56] **References Cited**

UNITED STATES PATENTS

3,620,269	11/1971	Lange	30/381
3,698,455	10/1972	Frederickson	30/381
3,733,700	5/1973	Notaras	30/381

Primary Examiner—Al Lawrence Smith
Assistant Examiner—J. C. Peters
Attorney, Agent, or Firm—McDougall, Hersh & Scott

[57] **ABSTRACT**

A gasoline powered internal combustion engine is directly and rigidly mounted to the frame of the portable chain saw such that upon operation of the engine the frame means vibrate at a disturbing frequency W. A handle in the form of an elongated, homogeneous, flexible member has at least one end thereof rigidly secured to the frame means. This handle, as a consequence of its material composition, of its shape and of the manner of its connection to the frame means, has a natural vibratory frequency *Wn*, such that

$$\frac{W}{Wn} > \sqrt{2}.$$

8 Claims, 6 Drawing Figures

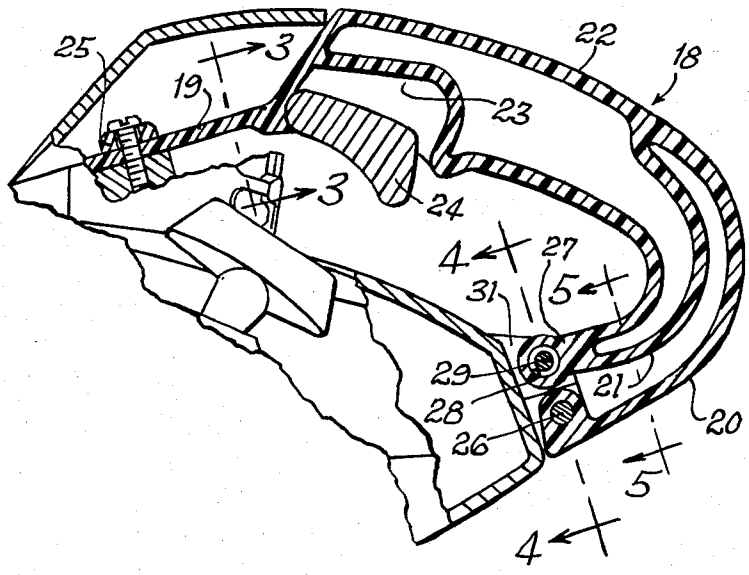


FIG. 1

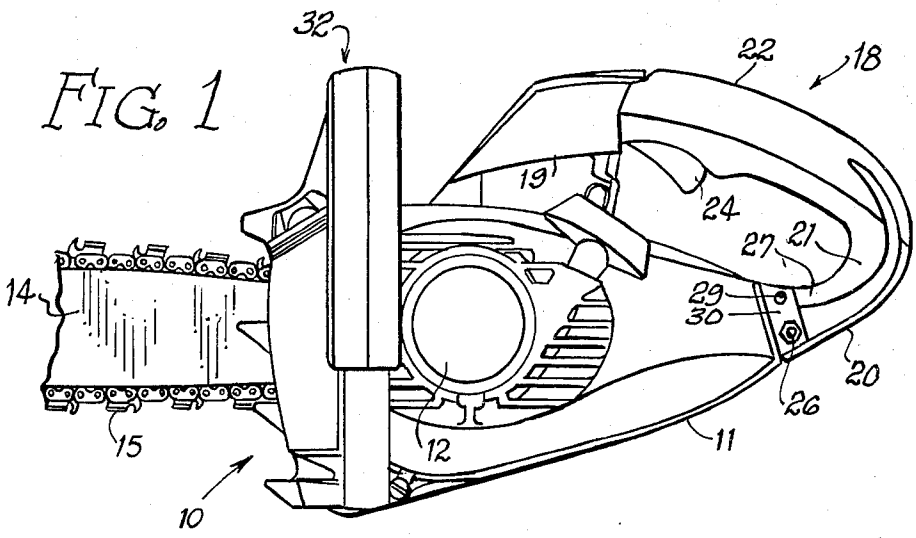


FIG. 3

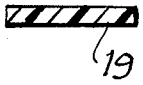


FIG. 2

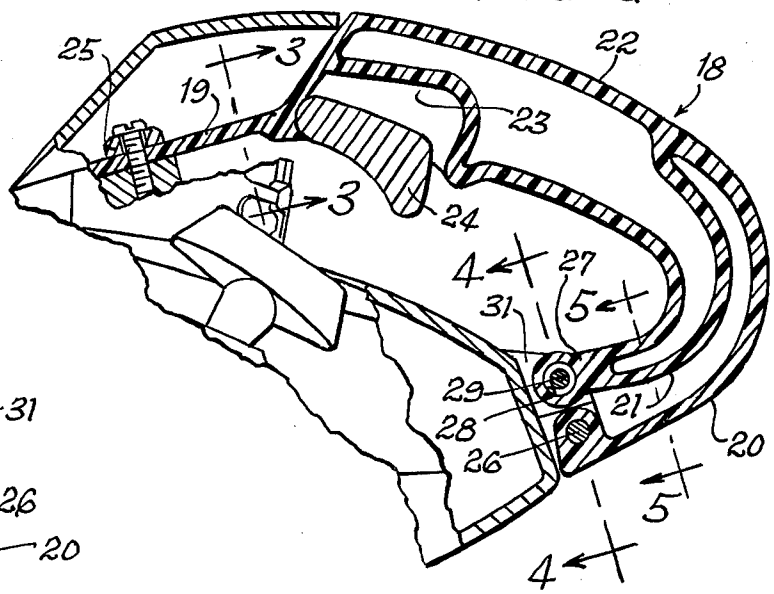


FIG. 4

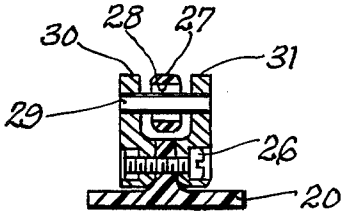


FIG. 6

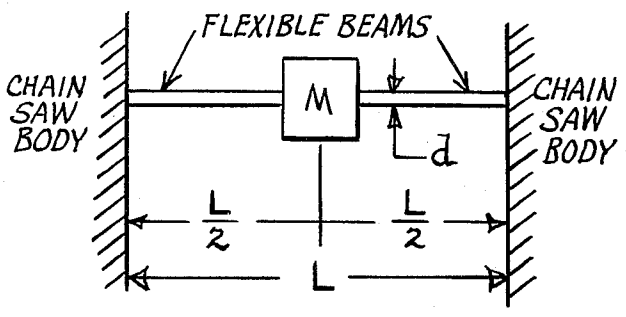
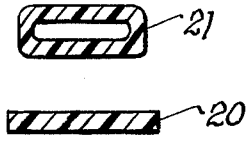


FIG. 5



VIBRATION ISOLATION HANDLE FOR PORTABLE CHAIN SAW OR THE LIKE

DESCRIPTION OF THE INVENTION

1. Field of the Invention

The present invention relates to vibration isolation handle construction for portable power tools of the type which are subjected to considerable vibration during their operation. In particular, the present invention relates to vibration isolation handle construction for a portable chain saw or the like powered by an internal combustion engine.

2. The Prior Art

Various attempts have been made to provide vibration isolation handle construction for portable power tools which are subjected to considerable vibration, such as portable chain saws. One form of prior art construction involves isolating the internal combustion engine of the portable chain saw from the frame and handle of the tool by various cushion members. Reference is made to U.S. Pat. Nos. 3,140,746; 3,224,473; 3,372,718; 3,409,056; 3,525,373; 3,530,909 and 3,542,095, for examples of this construction.

Although the technique of isolating the internal combustion engine from the power tool frame by means of cushions is generally satisfactory in reducing vibration transmitted to the handle to a sufficient degree, such construction complicates mounting of the internal combustion engine with the attendant increase in the cost of manufacture and assembly. Further, these cushions, which are made of resilient material, are subjected to rather rapid failure by fatigue.

According to another technique for isolating vibration in a portable chain saw, a handle has a core fixed rigidly to the chain saw body and a sheath surrounds the core in spaced relation thereto and is movable relative to the core in radial directions, as by means of elastic material interposed between the core and the sheath. With respect to this prior art construction, reference is made to U.S. Pat. No. 3,620,269. This type of handle, by reason of its plural parts, is somewhat expensive to construct. Another disadvantage of this form of handle resides in the loss of control over the tool by the operator to some degree resulting from relative movement between the handle core and the sheath, the latter of course being the member which is grasped by the operator's hand.

SUMMARY AND OBJECTS OF THE INVENTION

The disturbing frequency of vibration of the portable power tool, i.e., the vibration which is to be isolated to prevent operator fatigue, may be designated as W. The natural vibratory frequency of the handle of such tool may be designated as Wn. Vibration isolation at the handle may be achieved when the following formula is satisfied:

$$\frac{W}{Wn} > \sqrt{2}.$$

According to the present invention, the internal combustion engine of the portable tool may be directly and rigidly mounted to the frame of the tool. The handle is formed of an elongated, homogeneous, flexible member. First and second connection means respectively connect opposite ends of the handle to the frame with at least one end of the handle being rigidly secured to the frame. Such handle, as a consequence of its material composition, of its shape, and of the action of the first and second connection means, has a natural vibratory frequency such that

$$\frac{W}{Wn} > \sqrt{2}.$$

A primary object of the present invention is the provision of a vibration isolation handle for a portable power tool, such as a chain saw, wherein said handle is in the form of an elongated, homogeneous, flexible member having at least one end thereof rigidly secured to the frame of the tool, whereby vibration at the handle may be isolated to the requisite degree notwithstanding the direct mounting of the internal combustion engine to the frame.

Another object of the present invention is the provision of vibration isolation handle construction according to the foregoing object and wherein both ends of the handle are rigidly secured to the frame of the power tool.

Still another object of the present invention is the provision of a handle construction of the type described, wherein one end of the handle is rigidly secured to the frame of the power tool and wherein the means connecting the other end of the handle to the frame means include a resilient member.

Yet another object of the present invention is the provision of vibration isolation handle construction of the type referred to in the foregoing object, and wherein stop means are provided to limit the amount of relative movement between the frame means and such other end of the handle.

These and other objects and advantages of the present invention will become apparent from the following specification disclosing a preferred embodiment shown in the accompanying drawings.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side elevational view of a portable chain saw embodying the present invention;

FIG. **2** is an enlarged vertical central section of the main or pistol-grip handle of the chain saw illustrated in FIG. **1**;

FIG. **3** is a section taken along the line **3—3** of FIG. **2**;

FIG. **4** is a section taken along the line **4—4** of FIG. **2**;

FIG. **5** is a section taken along the line **5—5** of FIG. **2**; and

FIG. **6** is a schematic drawing of the pistol-grip handle of FIG. **2.**

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIGS. **1** through **5,** a portable chain saw, generally designated **10,** includes a frame **11** which may be integral with the housing of the tool or suitably secured thereto. A gasoline powered internal combustion engine **12** is directly and rigidly secured to the frame **11.** The power tool includes the usual chain guide **14** for guiding the endless cutting chain **15.** It will be understood that the chain guide **14** may be rigidly secured to the frame **11.** Since portable chain saws of the type just referred to are well known to those skilled in the art, the foregoing description of such chain saw

is adequate for an understanding of the present invention to be described hereinbelow.

Because the gasoline powered internal combustion engine **12** is rigidly and directly mounted to the frame **11** without the use of cushioning means of any kind, the frame of the power tool **10** will consequently be subjected to considerable vibration. Such vibration of the frame **11**, i.e., the disturbing frequency which is to be isolated from the operator to prevent fatigue, will be designated herein as W. This frequency is usually expressed in cycles per second (cps).

The main or pistol-grip handle associated with the power tool **10** and constructed in accordance with the present invention is generally designated **18**. This handle is in the form of an elongated, homogeneous, flexible member having end portions **19, 20** and **21** and an integral intermediate section **22**. The end portions **19, 20** and **21** are of a cross-section as illustrated in FIGS. **3** and **5**. The intermediate portion **22** of the handle **18** is of enlarged hollow construction and includes a cavity **23** mounting an operating trigger **24** for controlling the speed of the internal combustion engine **12**.

It will be understood that the end portions **19** and **20** of the handle **18** are directly and rigidly connected to the frame **11** of the portable chain saw by respective fasteners **25, 26**. Under certain circumstances, one or both ends of the handle may be integral with the adjacent frame parts. The handle is preferably constructed of a plastic material, although certain metals may be used. The end portions **19** and **20**, by reason of their cross-sectional shape, will impart a certain degree of flexibility to the handle **18**.

The natural vibratory frequency of the handle **18** is designated herein as Wn. The value of the frequency Wn will be determined by the material composition used to form the handle, by the shape of the handle, and by the manner in which opposite ends of the handle are secured to the frame **11**. As mentioned above, in the embodiment of the invention shown in FIGS. **1** through **5**, the end portions of the handle **18** are rigidly secured to the frame **11** of the tool.

According to the principles of the present invention, it has been ascertained that the disturbing vibration frequency W of the power tool frame may be isolated at the handle when $W/Wn > \sqrt{2}$. The larger the ratio of W/Wn, the greater will be the degree of vibration isolation at the handle. According to the embodiment shown in FIGS. **1** through **5**, the aforementioned ratio is satisfied by reason of the shape of the handle **18**, the material composition from which it is constructed, and by the manner in which opposite ends of the handle are rigidly secured to the frame **11** of the portable chain saw.

The hollow rectangular-in-cross-section end portion **21** of the handle **18** terminates in a solid portion **27** which includes an aperture **28** in its distal end. It will be understood that the handle portion **20** is substantially more flexible than the handle portion **21** since the former is much thinner in cross-section than the latter, as best seen in FIG. **5**. A pin **29** is received within the aperture **28**, normally in spaced relationship with the walls of the latter. Opposite ends of this pin are received in apertures respectively formed in bracket plates **30, 31**, the latter being rigidly secured to the frame **11**. The end portion **21** of this handle permits the same from being overstressed, since the application of abnormal forces to the handle would result in the wall of the aperture **28** coming into engagement with the pin **29** in which event further deflection of the handle could be achieved only by deforming the relatively stiff handle portion **21**.

The handles heretofore described for the portable chain saw **10** have been characterized as the main or pistol-grip type. As is known to those skilled in the art, portable chain saws of the type under consideration are provided with a secondary or auxiliary handle to facilitate manipulation of the power tool by the operator. Such an auxiliary handle, generally designated **32** (FIG. **1**), may also be constructed in accordance with the principles of the present invention.

A handle may be constructed in accordance with the principles of the present invention by the formulas to be referred to hereinbelow. It will be understood that the sample calculations to be set forth are for purposes of illustration only and shall not limit the scope of the invention in any way.

By way of illustration, it will be assumed that the following calculations have reference to the embodiment of the handle illustrated in FIGS. **1** through **5** and shown schematically in FIG. **6**. It is to be assumed that the handle end portions **19, 20** are of uniform rectangular, solid, cross-section as shown in FIGS. **3** and **5** with the width of these handle portions being designated as *b* and with the thicknesses designated *d*.

Assume that the portable chain saw has a 2 h.p. gasoline engine which develops a disturbing frequency W of 175 cps. It will be assumed further that the desired ratio of W/Wn is 5; therefore, $Wn = 35$ cps. The natural frequency for the handle under consideration may be represented by the formula

$$Wn = \frac{1}{2\pi}\sqrt{\frac{192\,EI}{ML^3}}$$

wherein *E* is modulus of elasticity of the handle, *I* is the moment of inertia thereof, *M* is the mass of the operator's hand and the mass of the handle, and *L* is the distance from one mounting point of the handle to the other. In other words, *L* for the handle under consideration would be the distance from points on respective end portions of the handles at their junctures with the frame **11**.

$$\text{Assume } M = \frac{0.0026 \text{ lbs-sec}^2}{\text{in.}} \text{ and that } L = 6 \text{ in.}$$

Substituting in the above referred to formula for the natural frequency Wn of the handle, we find that $EI = 141.31$ lbs-in.^{2}. We will assume that the handle is constructed of acetal plastic wherein $E = 410{,}000$ psi. Therefore, $I = 0.000345$ in.^{4}. Assuming the width *b* of the handle to be one inch, $I = bd^3/12$; therefore, $d = 0.160$ inch.

The stress *S* at the points wherein opposite ends of the handle are rigidly secured to the frame may be expressed as $S = PLd/16I$, wherein *P* is the force applied to the handle by the operator in pounds. In order to compute the maximum stress, we will assume that $P = 30$ lbs. before the overload pin **29** is contacted by the wall of aperture **28**. Substituting in the formula just mentioned, we find that $S = 5{,}250$ psi. This value is acceptable since the yield strength of the acetal plastic material is 14,000 psi.

Accordingly, it is seen from the aforesaid calculations that a plastic handle can be constructed according to a predetermined shape so that it is both flexible enough to achieve the requisite vibration isolation and yet strong enough to resist the forces to which it will be subjected during ordinary use. It should be apparent that the present invention provides new and improved handle construction for isolating the disturbing frequencies in a portable tool, such as a gasoline powered chain saw.

The handle is of simple, homogeneous construction with at least one end thereof rigidly secured to the frame of the power tool thereby simplifying the manner of connecting the handle to the tool. The present invention permits vibration to be isolated to a desired degree, notwithstanding the fact that the internal combustion engine is directly mounted to the frame of the power tool. Such mounting for the internal combustion engine simplifies the construction of the power tool and avoids the problem of prior art tools resulting from failure of the cushions or pads which mount the internal combustion engine to the frame.

I claim:

1. In a portable tool of the type which is powered by an internal combustion engine, the improvement comprising:

a. said tool including frame means;

b. an internal combustion engine directly and rigidly mounted on said frame means whereby upon operation of said engine said frame means vibrates at a disturbing frequency W;

c. a handle in the form of an elongated, flexible member, said handle being of unitary, homogeneous construction such that all portions of the handle vibrate together in unison; and

d. first and second connection means respectively, connecting opposite ends of said handle member to said frame means with at least one end of said handle member being rigidly secured to said frame means by said first connection means, said handle member, as a consequence of its material composition, of its shape and of the action of said first and second connection means, having a natural vibratory frequency Wn such that

$$\frac{W}{Wn} > \sqrt{2.}$$

2. The improvement according to claim **1** further defined by, stop means limiting the amount of relative movement between said frame means and said other end of the handle member.

3. The improvement according to claim **1** wherein the other end of the handle member is rigidly secured to said frame means by said second connection means.

4. The improvement according to claim **3** wherein said handle member is of one-piece construction.

5. The improvement according to claim **3** wherein said other end of the handle member is defined by first and second elongated elements with said first element being rigidly secured to said frame means and being substantially more flexible than said second element as a consequence of the shape of the former, the distal end of said second element being free to move relative to said frame means, and stop means mounted on said frame means and arranged to be engaged by said distal end of said second element thereby to limit the amount of relative movement between the latter and said frame means.

6. The improvement according to claim **3** wherein said handle member is defined by two end portions and another portion intermediate said end portions, said end portions being shaped so as to be substantially more flexible than said another portion.

7. In a portable tool of the type which is powered by an internal combustion engine, the improvement comprising:

a. said tool including frame means;

b. an internal combustion engine directly and rigidly mounted on said frame means whereby upon operation of said engine said frame means vibrates at a disturbing frequency W;

c. a handle in the form of an elongated, homogeneous, flexible member;

d. first and second connection means rigidly connecting respective opposite ends of said handle member to said frame means, said handle member, as a consequence of its material composition, of its shape and of the action of said first and second connection means, having a natural vibratory frequency Wn such that

$$\frac{W}{Wn} > \sqrt{2;} \text{ and}$$

e. one end of said handle member being defined by first and second elongated elements with the first element being rigidly secured to said frame means and being substantially more flexible than said second element as a consequence of the shape of the former, the distal end of said second element being free to move relative to said frame means, and stop means mounted on said frame means and arranged to be engaged by said distal end of said second element thereby to limit the amount of relative movement between the latter and said frame means.

8. In a portable tool of the type which is powered by an internal combustion engine, the improvement comprising:

a. said tool including frame means;

b. an internal combustion engine directly and rigidly mounted on said frame means whereby upon operation of said engine said frame means vibrates at a disturbing frequency W;

c. a handle in the form of an elongated, homogeneous, flexible member;

d. first and second connection means rigidly connecting respective opposite ends of said handle member to said frame means, said handle member, as a consequence of its material composition, of its shape and of the action of said first and second connection means, having a natural vibratory frequency Wn such that

$$\frac{W}{Wn} > \sqrt{2;} \text{ and}$$

e. said handle member being defined by two end portions and another portion intermediate said end portions, such end portions being shaped so as to be substantially more flexible than said another portion.

* * * * *