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VIBRATION ABSORBING MOUNTING FOR OUTBOARD MOTORS

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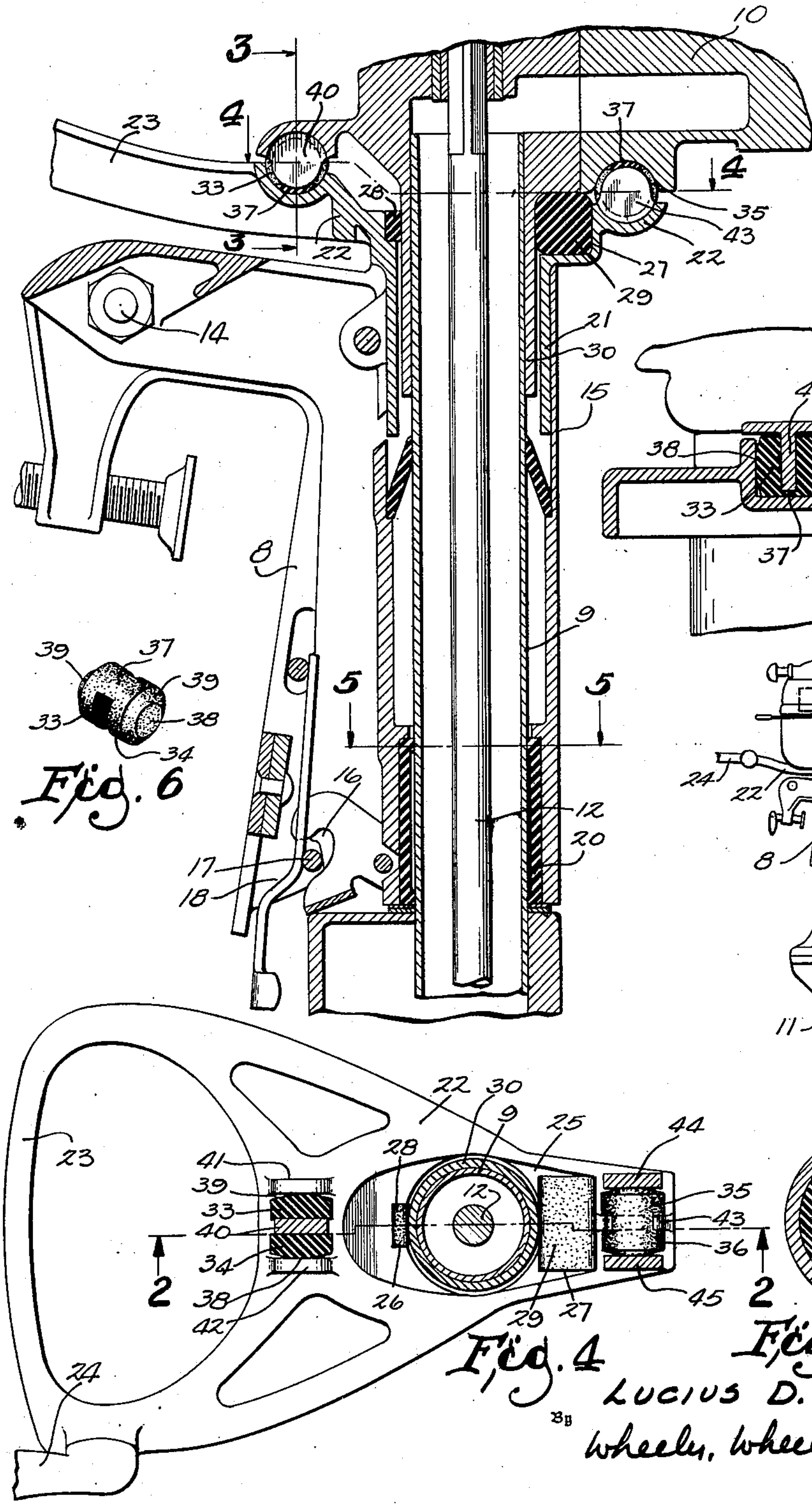

Fig. 2

Fig. 3

Fig. 1

Fig. 6

Fig. 4

Fig. 5

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VIBRATION ABSORBING MOUNTING FOR OUTBOARD MOTORS

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17 Claims. (Cl. 115—18)

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This invention relates to vibration absorbing mountings for outboard motors.

It is the primary object of the invention to provide novel and improved means offering variable damping resistance to the various forms of vibration to which an outboard motor is subject, the damping means offering materially greater resistance to vibration in some planes than to vibration in other planes and, in addition, offering a resistance which varies according to the intensity of the vibration. The manner in which these objectives are achieved will be more particularly explained in connection with the following disclosure of the invention.

In the drawings:

Fig. 1 is a view in side elevation of an outboard motor embodying the invention, this being a somewhat diagrammatic or phantom view showing the pistons, connecting rods, crank shaft, fly wheel, drive shaft and propeller shaft of the outboard motor in dotted lines.

Fig. 2 is an enlarged fragmentary detail view in longitudinal axial section taken on line 2—2 of Fig. 4 through the intermediate portions of the outboard motor and its mounting bracket.

Fig. 3 is a view taken in section on line 3—3 of Fig. 2.

Fig. 4 is a view taken in section on line 4—4 of Fig. 2.

Fig. 5 is a view taken in section on line 5—5 of Fig. 2.

Fig. 6 is a detail view in perspective showing one of the double cushioning elements as desirably used in practice of the invention.

As is usual, the outboard motor comprises a transom bracket 8 and a shaft housing 9, the shaft housing carrying at its upper end the prime mover 10 and at its lower end a gear housing 11. The prime mover drives the vertical shaft 12 which extends downwardly through housing 9 to housing 11 for actuating the propeller 13.

The transom bracket 8, which is clamped to the transom of the boat to be propelled, is provided, in accordance with conventional practice, with a transverse pintle at 14 upon which there is pivotally carried a sleeve 15 within which the entire assembly of the power head 10, a shaft housing 9, the "lower unit" 11 and propeller 13 are swiveled on a vertical axis for steering. The upright position of sleeve 15 and the assembly swiveled therein is determined by engagement of thrust member 16 with a thrust receiving element 17 that is adjustable in the segments 18 of the bracket, the adjustment preferably being made in accordance with disclosure of co-pending application Serial No. 13,036, filed March 4, 1948 and entitled Outboard Motor Thrust and Tilt Lock Adjustments now U. S. Patent No. 2,583,910 dated January 29, 1952. There is a bushing at 20, desirably made of rubber, interposed between the shaft housing 9 and the sleeve 15 near the lower end of this sleeve. The propeller thrust developed by the rotation of the propeller 13 is communicated to the gear housing or lower unit 11 and thence to the shaft housing 9 and thence through the bushing 20 to the sleeve 15 and thence via member 16 and element 17 to the bracket 8 and the transom of the boat. Since the thrust transmission to the thrust receiving element 17 occurs at a level materially above the level of the propeller 13, a thrust moment is developed, tending to pivot the entire dirigible assembly about the horizontal transverse axis represented by the thrust receiving element 17. Thus there is a tendency for the upper end of the shaft housing to move rearwardly under thrust of the propeller, this tendency being resisted in the manner hereinafter explained.

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Rotatively fitted within the upper end of the sleeve 15 is a sleeve 21 with which there is rigidly connected a yoke 22 (Fig. 4) which may integrally provide a steering handle 23 and to which the tiller 24 is connected. Where the yoke attaches to the inner sleeve 21, there is formed an enlarged chamber 25 (Fig. 4) having a relatively small forward pocket at 26 and a relatively larger rear pocket 27 in which there are rubber cushions at 28 and 29, respectively (Figs. 2 and 4). Each of these cushions may extend substantially rectilinearly at its inner margin to receive the sleeve 30 into which the upper end of the shaft housing 9 is braced or otherwise fastened. The sleeve 30 serves as a means of mounting the power head 10 on the upper end of the shaft housing.

It will be observed that the sleeve 30 is materially smaller in diameter than the interior diameter of sleeve 21, so that there is substantial clearance between these sleeves as best shown in Fig. 2. Thus, the shaft housing and power head are free to move fore and aft, laterally, and torsionally respecting the tiller-connected sleeve 21 and the sleeve 15 in which the tiller-connected sleeve 21 is rotatable. The rubber cushions at 28 and 29 are desirably made to absorb fore and aft thrust only, and to damp fore and aft vibration only. Because of the tendency of the dirigible assembly to pivot about the thrust element 17 in response to the thrust of the propeller 13, thereby tending to move the upper end of the shaft housing 9 rearwardly, as above pointed out, the cushion 29 is made very materially larger than cushion 28, cushion 28 having relatively little thrust exerted upon it. The reason why, in this preferred embodiment of the invention, the cushions 28 and 29 absorb longitudinal fore and aft thrust only is because their surfaces with which sleeve 30 is engaged are, in this exemplification, substantially rectilinear transversely of the device, as clearly appears in Fig. 4. So far as these cushions are concerned, the sleeve 30 and shaft housing 9 can move laterally with complete freedom to the limit permitted by the enclosing sleeve 21.

According to the design of the power head 10, assuming this to be an internal combustion engine, the movement of the pistons and connecting rods will set up vibration which may be either in a fore and aft direction or in a transverse direction. The reason why it is preferred that the cushions 28 or 29 act in a fore and aft direction only is because, by separating the fore and after damping means from the lateral damping means, it is possible to select cushions having exactly the desired damping characteristics for the performance of the desired damping operation in the particular planes in which respectively they act.

In the present device, the means which damps lateral vibration also damps torsional vibration. Torsional vibration is an important factor in an outboard motor and tends to oscillate the power head shaft housing and lower unit to and fro upon a vertical axis which, desirably, may coincide approximately with the axis of the drive shaft 12. The torque transmitted to the propeller through the drive shaft 12 is generated by well defined impulses, whether the prime mover is an internal combustion engine with reciprocating pistons or whether it is a motor or turbine. During the power impulses, a reaction equal to the maximum torque is developed in the cylinder or other frame of the prime mover. During the interval between such impulses, there is a tendency for the fly wheel effect of the shaft and associated parts to communicate torque in an opposite direction to the cylinder or other frame of the prime mover. Thus the entire prime mover and the shaft housing 9 and lower unit 11 tend to oscillate as a unit about a vertical axis as aforesaid.

Such oscillation can best be resisted and damped by cushions which are radially remote from the axis upon which oscillation occurs. If, as in the instant device, the cushions are also used to resist and to damp lateral vibration of the assembly within the bearing, these cushions should be disposed at opposite sides of a fore and aft plane.

With the foregoing objectives in view, I provide pairs of cushions respectively shown at 33, 34 and 35, 36, the cushions of each pair being, for convenience, but not necessarily, connected together as a unit by a thin web 37 of the material of which the cushions are formed.

The external shape of the cushions is important. Each has an end bearing surface 38 which is materially smaller in area than the general cross section of the cushion in an adjacent parallel plane. For the purpose of exemplifying the invention, the respective cushions are shown as being cylinders having ends frusto-conically tapered at 39 to the terminal bearing surfaces 38 above described. The opposite ends of the individual cushions, here shown as their inner contiguous ends, across which the web 37 is connected, may be parallel.

As clearly shown in Figs. 2, 3 and 4, one pair of cushions is located on the longitudinal center line of the outboard motor forwardly of the axis of shaft 12 (or other axis of oscillation), while another pair of cushions is located aft of such axis. Cushions of the respective pairs are desirably located at opposite sides of the longitudinal center line.

One of the relatively oscillatable parts of the outboard motor has an ear confined between the cushions, while the other relatively oscillatable part of the outboard motor has ears engaged externally with the reduced terminal surfaces 38 of the cushions. It so happens that in the particular device illustrated, it is the power head 10 which, on the forward side of the drive shaft 12 is provided with an ear at 40 engaged between cushions 33 and 34, the yoke 22 having the ears 41 and 42 engaged with the reduced thrust surfaces 38 of cushions 33 and 34 to limit the lateral displacement of the cushions under thrust of the ear 40. It further happens that in this particular exemplification of this invention, the situation is reversed so far as the rear set of cushions is concerned. In the rear pair of cushions, it is the yoke 22 which provides the central ear at 43, while the power head 10 provides the outside ears 44 and 45 as shown in Fig. 4.

Study of Fig. 4 will disclose that bodily lateral displacement of the power head 10 in a direction away from the observer will be resisted by cushions 33 and 35 and bodily movement of power head 10 toward the observer will be resisted by cushions 34 and 36. Clockwise oscillation of the power head 10 with respect to the tiller yoke 22 will subject cushions 33 and 35 to compression while counterclockwise oscillation of the power head respecting the tiller head will subject cushions 34 and 36 to compression. The particular cushions which are compressed will, in any given design, depend upon which of the ears confronting the cushions are connected to the respective parts subject to torsional movement.

The importance of having the respective cushions tapered toward terminal bearing surfaces lies in the fact that thereby the resistance of the cushion is proportioned to the displacement. In a rapidly operating prime mover, the amplitude of torque vibration, and other vibration, is relatively limited. Under such circumstances, the respective cushions are only slightly compressed and, in the course of slight compression, the surfaces acted upon are of relatively slight area so that the damping resistance is at a minimum. When the prime mover operates at slower speeds, the power impulses are farther apart and the amplitude of vibration is great. Under these conditions, the cushions become more highly compressed and, as they are compressed, their tapered portions flatten out so that a greater and greater surface is engaged by that flange or ear against which the cushion is being compressed. This increases the resistance of the cushion proportionately to the pressure, the pressure, in turn, increasing proportionately to the amplitude. Thus, there is relatively great resistance and relatively great damping effect when vibration tends to be severe and relatively less resistance and less damping when the vibration is moderate.

It will be apparent that with the device disclosed there will be very little vibration of any sort transmitted to the transom bracket and the boat. Most of the fore and aft vibration is absorbed in blocks **28**, **29**. In any event, the prime mover design will desirably be such as to minimize fore and aft vibration. The lateral vibration and the torsional vibration will be largely absorbed in the cushions **33**, **34** and **36**. Such transverse vibration as passes the cushions will be substantially equal both fore and aft of the vertical central axis through the center of mass and consequently the transverse vibration will be absorbed in the sleeve **15** and the transom bracket. Such torsional vibration as remains undamped by the cushions will be transmitted torsionally to the tiller-connected sleeve **21** and will tend merely to oscillate such sleeve idly within the swivel bearing **15**.

While I have shown the cushions paired in integral units, it will be understood that this is merely preferred practice and is not essential to the invention. It is also immaterial in a broad sense that I have shown the tapered surfaces of the cushions directed outwardly rather than inwardly. Except as indicated in the appended claims, I do not desire to limit the invention to the particular form or disposition of the cushions illustrated.

The cushions used are desirably made of natural or synthetic rubber rather than metal springs, rubber having the greater damping effect. As is well known in the art, the composition of the rubber may be varied to control the resistance offered by the respective cushions according to the pressure to which they will be subject in use. Further control is possible by changes in size, porosity and shape, according to design requirements.

I claim:

1. In an outboard motor the combination with a unit comprising power head, shaft housing, and lower unit, and a transom bracket mounting therefor with which said unit is in tiltable relation, of mounting means between the unit and said bracket mounting providing for movement therebetween whereby said unit is free to vibrate fore and aft and transversely, a first damping cushion means positioned between the unit and the bracket mounting for resisting fore and aft vibration, and a second and entirely separate damping cushion means between the unit and the bracket mounting for resisting lateral vibration, said second damping cushion means comprising a cushion forward of the shaft housing and another cushion aft of the shaft housing.

2. The device of claim 1 in which said unit is also subject to torsional vibration upon an upright axis, and one of said cushion means comprises cushions at opposite sides of said axis confined between said unit and said bracket mounting in positions to resist torsional vibration in addition to resistance of the vibration previously mentioned.

3. In an outboard motor, the combination with a transom bracket and a swiveled dirigible unit comprising power head, shaft housing, and gear housing, of a sleeve through which said shaft housing extends in spaced relation to the sleeve, means for transmitting thrust of said shaft housing to said transom bracket, a thrust absorbing cushion aft of the upper end of the shaft housing and having a transverse surface contacting the housing only adjacent its fore and aft center line and resisting only rearward displacement of the said upper end in said sleeve in response to thrust developed at said gear housing.

4. In an outboard motor, the combination with a support provided with a swivel bearing, of a dirigible upright unit having a power head at its upper end and a propeller at its lower end, said unit having means pivoted upon said bearing for dirigible movement, said bearing including separate lower and upper bearing portions, the upper bearing portion comprising yieldable cushions having with respect to the upright unit transversely extending and longitudinally spaced surfaces engaging said member fore and aft and leaving said member relatively free for lateral vibration, said member and support having fore and aft of said unit separate mutually engaged means for resisting lateral vibration.

5. The combination set forth in claim 4 in which the aft cushion is materially larger than the cushion forward of said member.

6. In an outboard motor, the combination with a transom bracket, a tiller member pivotally movable respecting the transom bracket, and a motor member having a prime mover at its upper end and a propeller at its lower end connected for unitary steering movement and mounted for oscillation coaxially with said tiller member, of cushion means interposed between said members and comprising a pair of cushions forwardly of said axis, another pair of cushions rearwardly of said axis, and thrust abutments connected with the respective members and between which the cushions of the respective pairs are confined to resist displacement of either member with respect to the other in either direction.

7. In an outboard motor having a transom bracket provided with a thrust element and a swivel bearing sleeve pivoted on a transverse axis to the transom bracket and provided with a thrust member engageable with said element at a point materially below the said axis, the combination with such sleeve of a tiller member swiveled therein and having portions extending forward and aft of said sleeve, a motor member extending loosely through the tiller member and through the swivel bearing sleeve and provided with a cushion positioning it in the latter, the motor member having a prime mover above said transverse axis and a propeller operatively connected with the prime mover and disposed below said sleeve, cushions fore and aft of the motor member for yieldably locating it in a fore and aft direction in the tiller member through which it loosely extends, and separate cushions interposed between the motor member and the tiller member both forward and aft of the sleeve and resisting lateral displacement thereof.

8. The device of claim 7 in which said separate cushions are arranged in pairs respectively fore and aft of the motor member, the respective pairs being symmetrically disposed with reference to a longitudinal line drawn fore and aft through the motor member, one of said members having a thrust flange between the cushions of each pair and another member having spaced flanges engaged externally with the cushions of each pair.

9. In an outboard motor for normal forward propulsion, a power unit having a shaft and shaft housing connected to a lower propulsion unit subject to thrust, a bracket and tiller assembly provided with an oversize sleeve for reception of the shaft housing whereby in the operation of the outboard motor the thrust may shift the housing in said sleeve, and oppositely positioned cushions between the sleeve and the shaft housing having transverse surfaces substantially tangent to the upper end of the shaft housing on its fore and

aft center line and free of said housing elsewhere, one of said cushions being smaller than the other, the larger cushion being positioned to resist thrust of the propulsion unit in forward propulsion.

10. In an outboard motor for normal forward propulsion, a power unit having a shaft and shaft housing connected to a lower propulsion unit subject to thrust, a bracket and tiller assembly provided with an oversized sleeve for reception of the shaft housing whereby in the operation of the outboard motor the thrust may shift the housing in said sleeve, said tiller having fore and aft cupped receptors for cushions, cushions in said receptors, and the power unit having complementary fore and aft means for engagement with said cushions, said receptors and cushions being spaced from the shaft housing.

11. In an outboard motor a power unit having a shaft and shaft housing connected to a lower propulsion unit subject to thrust, a bracket for attachment of the outboard motor to a support and provided with a sleeve-like mounting to loosely receive the shaft housing, a tiller assembly having a tiller sleeve loosely receivable between the shaft housing and said bracket sleeve, the tiller assembly being yoke-shaped about the shaft housing and providing cushion confining means at points spaced from the shaft housing and approximately diametrically opposite one another under the power head, said power unit having portions overlying said cushion confining means and having complementary means for engagement with said cushions whereby to assist in centering the power head and shaft in said bracket sleeve.

12. An outboard motor comprising the combination with an oscillatable unit comprising a power head shaft housing and lower unit, of a mounting therefor in which said unit is free to vibrate fore and aft and transversely, a first damping cushion means resisting fore and aft vibration, said cushion means having thrust receiving contact with said unit substantially only at diametrically opposed points spaced fore and aft, whereby to leave said unit relatively free for transverse vibration, and a second and entirely separate damping cushion means having lateral thrust receiving connection between said mounting and said unit to resist torsional vibration.

13. The device of claim 12 wherein said first and second damping cushion means are substantially aligned fore and aft on the axis of normal fore and aft vibration of the unit.

14. The device of claim 12 wherein said cushion means resist vibration in compression, the axis of compression of the first cushion means being transverse to that of the second cushion means.

15. The device of claim 12 wherein said first and second cushion means are substantially aligned on the axis of fore and aft vibration of the unit, said first cushion means having direct contact with said unit, and laterally spaced ears having connections with said unit and said mounting and between which said second cushion means is mounted.

16. In an outboard motor, the combination with a transom bracket and a swiveled dirigible unit, said transom bracket having a mounting for the dirigible unit, and yieldable cushions between said mounting and said unit, said cushions being disposed on the fore and aft axis of unit vibration and having rectilinear cushion surfaces transverse to said axis and against which the unit is in fore and aft thrust relationship but is relatively free for lateral vibration.

17. The device of claim 16 in further combination with a second vibration damping cushion means comprising yieldable cushions disposed at points radially offset from said unit and on opposite sides of said unit along said fore and aft axis, said unit and mounting being provided with complementary seats between which said second cushion means is disposed to absorb the torque vibration of said unit.

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