

Aug. 27, 1946.

G. W. FYLER

2,406,601

CUSHION MOUNTING

Filed April 21, 1943

2 Sheets-Sheet 1

Fig.1.

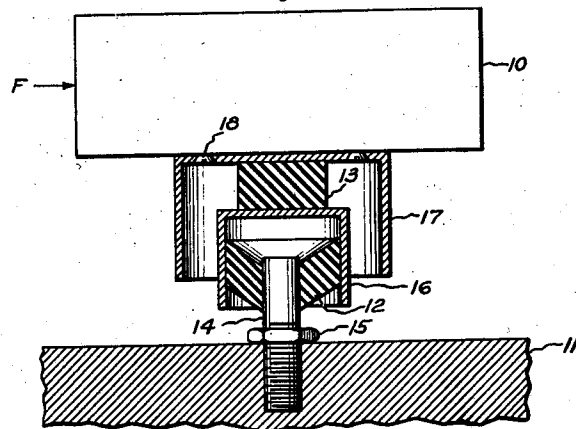


Fig. 2.

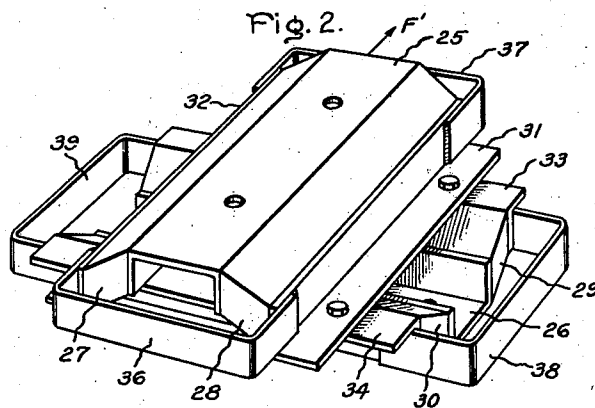
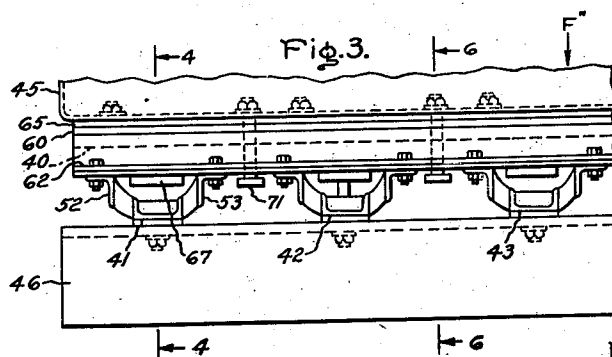


Fig.3.



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Fig. 5.

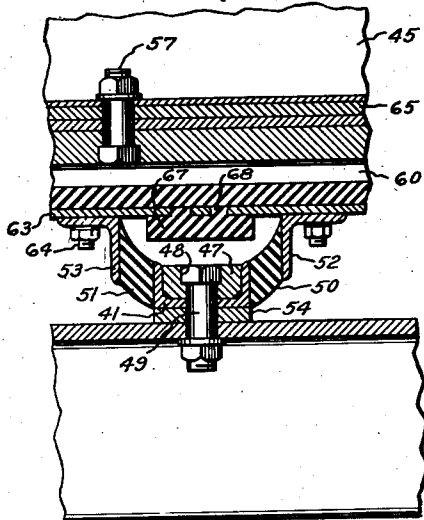


Fig. 4.

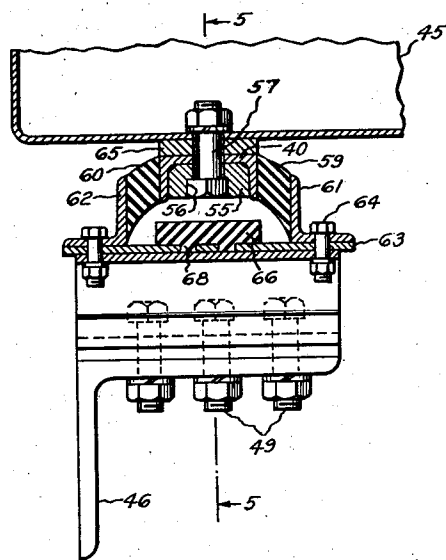


Fig. 7.

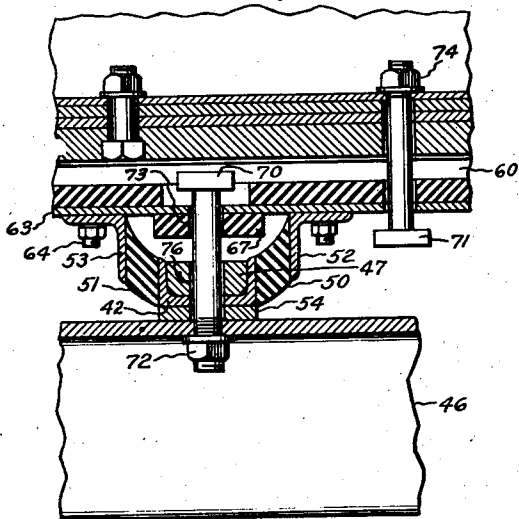
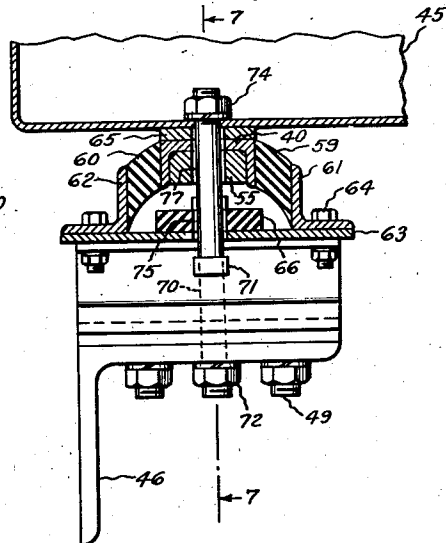


Fig. 6.



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UNITED STATES PATENT OFFICE

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CUSHION MOUNTING

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8 Claims. (Cl. 248—358)

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My invention relates to cushion mountings for sensitive apparatus subjected to severe shocks and vibrations and it has for its object to provide an improved cushion mounting having a large amount of flexibility along three mutually perpendicular axes.

Another object of my invention is to provide an improved cushion mounting for apparatus, subjected to exciting vibrations having a given frequency range, in which the resonant frequency of the mounting and supported apparatus is maintained considerably lower than the frequency of the exciting vibrations by causing the static deflecting force of the mass of the apparatus to set up shear stresses in a resilient supporting member.

A further object of my invention is to provide an improved cushion mounting in which the resilient members thereof are subjected to shearing stresses in all planes throughout a primary range of deflection and to compressional stresses throughout a secondary range of deflection.

The features of my invention which I believe to be novel are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawings.

In the drawings, Fig. 1 represents a cushion mounting according to my invention; Fig. 2 is a modification of the mounting shown in Fig. 1; Fig. 3 is a portion of a side elevational view of a modification of the mounting of Fig. 2; Fig. 4 is a sectional elevation view along the line 4—4 of Fig. 3; Fig. 5 is a sectional view along the line 5—5 of Fig. 4; Fig. 6 is a sectional elevation view of the mounting of Fig. 3 along the lines 6—6; and Fig. 7 is a sectional view of the mounting along the lines 7—7 of Fig. 6.

Referring to Fig. 1, I have shown a member 10 which is supported by a fixed supporting means 11. The member 10 may comprise any sensitive apparatus, such as a radio equipment, and the supporting means 11 may be subjected to undesirable vibrations and sudden impulse shocks. In order to prevent these vibrations from being imparted to the member 10, a pair of transverse resilient members 12 and 13 are interposed between the member 10 and the supporting means 11. The resilient members 12 and 13 may comprise circular rubber blocks or pads. The rubber member 12 is secured in any well known manner, as by bonding during vulcaniza-

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tion, to a metal stud 14, the lower portion of which is in threaded engagement with cooperating threads in the supporting block 11. A lock nut 15 is provided rigidly to secure the stud 14 to supporting block 11. The outer edges of the circular washer 12 are similarly bonded by vulcanization to the inner surface of a cylindrical metal member 16. A second cylindrical metal member 17 is attached to the apparatus 10 by means of screws 18 and is spaced from the upper surface of metal cylinder 16 by means of a rubber block 13. Block 13, similar to rubber member 12, is bonded to the upper surface of cylinder 16 and the inner surface of cylinder 17.

It is well known that when a mass is supported by a resilient member, the mass causes a certain deflection in the resilient mounting and the amount of this deflection can be used to calculate the resonant frequency of the system. For a given mass, the relationship is substantially linear and as the magnitude of the initial deflection increases, the resonant frequency of the system decreases. It is also known that the amplitude of vibration for such a system is greatest when the frequency of an exciting vibration is the resonant frequency of the system. For exciting vibrations of a frequency greater than the resonant frequency of the system, the amplitude of vibration of the system drops off and may become considerably smaller than that of the exciting vibration.

From the foregoing it is seen that, in order to protect a system against vibrations over a given frequency range, it is desirable to have the resonant frequency of the system considerably lower than the lowest frequency of that range so that the amplitude of vibration of the system at this lowest frequency is not greater than that of the exciting source and is considerably less than the higher frequencies in the range.

In order that the resonant frequency of the system (shown in Fig. 1) may be kept below a desired maximum value, the resilient members of the shock mounting are located in transverse planes so that forces from any direction initially produce shear stresses in the resilient members. Thus, the rubber member 12 is subjected to shearing stresses by forces in a vertical plane, while member 13 is subjected to shearing stresses by forces in all horizontal directions. The combination of the members 12 and 13 provides shear in all possible directions, since a force in any direction may be resolved into components in vertical and horizontal planes. Since the stiffness of a rubber mount in shear is approximately only

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one-fifth as great as the stiffness in compression, it is apparent that a mount constructed in accordance with Fig. 1 produces a large initial deflection and the resonant frequency of the system is kept to a low value.

When the mount of Fig. 1 is subjected to a force in a given direction, for instance, a force F acting to the right in Fig. 1, the rubber block 13 is subjected to shearing stresses over a given range. When a predetermined longitudinal deflection of block 13 is obtained, the inner surface of the vertical wall of member 17 contacts the outer surface of the vertical wall of cylinder 16 to compress the rubber member 12. Thus, when the shear range of block 13 is exceeded, the unit changes over to a gradual compression, or snubbing, action. Similarly, for a force acting downward on member 10, rubber block 12 is initially subjected to shearing stresses until the bottom edge of cylinder 16 contacts the upper surface of supporting member 11. Thereafter, the rubber block 13 is subjected to compression stresses until, ultimately, the lower edge of cylinder 17 contacts the upper surface of member 11. Such a cushion mounting provides a final limit to the deflection without any discontinuities in the cushioning action to affect adversely the member 10. In a practical system, when a cushion mounting of the type shown below the member 10 in Fig. 1 is also used above the member 10, this member, which may comprise sensitive control apparatus, is protected by two units working oppositely to cushion the apparatus against shocks and vibrations from all directions.

In Fig. 2 there is shown a modification of the cushion mounting in which two channel shaped members 25 and 26 are transversely disposed. The supported member 25 may be bolted to an object to be supported and supporting channel 26 may be bolted to a fixed support. Rubber blocks 27 and 28 are secured to the opposite sides of channel 25 and rubber blocks 29 and 30, to the opposite sides of channel member 26. The top and bottom faces of these rubber blocks are inclined at an angle to the horizontal so that the blocks 27 and 28 support channel 25 in an elevated position. Rigid members, such as angles 31 and 32, are secured to the outside faces of rubber blocks 27 and 28 and are bolted to the rigid angle members 33 and 34 secured to the outside faces of rubber blocks 29 and 30. In this manner the angles 31—34 form a unitary structure which acts as a substantially rigid member interposed between the resilient members 27 and 28 and the members 29 and 30. Accordingly, forces acting on the structure of Fig. 2 in the direction of F' cause, initially, shearing stresses in the members 27 and 28 and produce a longitudinal deflection of these members. In order to limit the longitudinal deflection of members 27 and 28 to a predetermined amount, as well as to provide means to change from shearing stresses in the members 27 and 28 to compressional stresses in members 29 and 30, the protective straps 36 and 37 are secured, as by welding, to the angles 31 and 32. Similarly, to limit to a predetermined value the deflection of resilient members 29 and 30, due to forces acting along the direction of the axis of channel 26, protective straps 38 and 39 are secured to angles 33 and 34. After a predetermined longitudinal deflection of members 29 and 30, the channel 26 contacts strap 38 or 39 to initiate compressional stresses in resilient member 27 or 28.

In the cushion mounting shown in Fig. 3, a

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channel member 40 of considerable length is supported by a plurality of shorter channel members 41, 42, 43 disposed at right angles to member 40. Details of the cushion mounting used with the channel members 40—43 are pointed out in the following description of Figs. 4—7. In the several Figs. 3—7 corresponding parts have been indicated by corresponding reference numerals.

Referring to Fig. 4, I have shown the cushion mounting for supporting body member 45 on a fixed support 46. A metal block 55 is provided within the elongated channel 40 and contains suitably shaped recesses 56 to receive the heads of bolts 57 used for securing the channel 40 and the block 55 to the supported member 45. A metal pad 65 is interposed between the upper surface of channel 40 and the bottom of the supported member 45 for purposes pointed out later. In the manner described in connection with the cushion mounting of Fig. 2, channel 40 has attached to it a pair of resilient members 59 and 60 and a pair of angle members 61 and 62 are attached to the opposite faces of these resilient members.

The elongated channel 41, as seen in Fig. 5, similarly contains a metal block 47 having recesses 48 for the reception of the heads of bolts 49 provided to secure rigidly the channel 41 and the block 47 to the support 46. Also, channel 41 is mounted on a metal pad 54, whose function is pointed out later. Similar to the structure shown in Fig. 4, the portion of the cushion mount shown in Fig. 5 is provided with resilient members 50, 51 and angle members 52, 53.

A metal plate 63 of substantially the same length as channel 40 is interposed between the opposing faces of angles 52, 53, and angles 61, 62 and is held rigidly in this position by fastening bolts 64 extending between the supporting angles 61, 62 attached to channel 40 and angles 52, 53 attached to channels 41—43.

In order to provide means to cushion the channel 41 and the metal block 47 from the metal plate 63, a rubber pad 67 is placed under the plate 63 and extends along this plate directly above the channel 41. Similarly, as may be seen in Figs. 4 and 6, in order to prevent the channel 40 and the block 55 from striking against the plate 63, a rubber pad 66 is placed upon the plate 63 and extends along this plate directly beneath the channel 40. The rubber pads 66 and 67 may be attached to the plate 63 by any suitable means, such as the locating projections 68 formed integrally with pads 66 and 67 and extending within cooperating holes provided for that purpose in the plate 63.

In order to provide means to limit vertical deflections of the cushion mounting of Fig. 3, as well as to provide means responsive to predetermined longitudinal deflections of one set of resilient members to produce lateral deflections of the transverse set of resilient members, T-headed bolts 71 and 70, best seen in Figs. 6 and 7, extend respectively between the supported member 45 and plate 63 and between support 46 and plate 63. The bolt 70 passes loosely through hole 76 in block 47 and is in threaded engagement with support 46, being securely fastened thereto by means of nut 72. It passes through rectangular slots 73 in plate 63 and rubber pad 67 to extend within the space between plate 63 and channel 40. Similarly, bolt 71 passes through hole 77 in member 55 and is in threaded engagement with supported member 45, being securely fastened

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thereto by means of nut 74. The head of bolt 71 likewise passes through a rectangular slot 75 in plate 63 and pad 66 to project between the channels 43 and 42. After being passed through the openings 73 and 75 in plate 63, the T-headed bolts 70 and 71 are turned so that the longer axes of the heads of these bolts are transverse to the longer sides of the rectangular openings 73 and 75.

When the cushion mounting illustrated in Figs. 3-7 is subjected to a force, for example, to the left in Fig. 3 along the axis of channel 40, the resilient members 50 and 60 are first subjected to shear stresses. After the force has produced deflection of a predetermined amount of members 50 and 60, the neck of bolt 71 engages the end of slot 75 in plate 63. If the force is sufficient to produce further deflection, the bolt 71, acting through the plate 63 and angle 53, compresses the resilient members 51. Ultimately the side of slot 75 of plate 63 strikes the neck of bolt 70 to prevent further movement of the mounting.

In a similar manner, forces transverse to the axis of channel 40 produce, in sequence, shearing stresses in rubber members 50 and 51, contact of bolt 70 with the end of slot 73, compression stresses in resilient member 60, and finally contact of bolt 71 with the side of opening 75. It is apparent, also, that forces acting downwardly in a vertical plane, such as the force F'' in Fig. 3, initially produce shearing stresses in members 50, 51 and 59, 60. After a predetermined deflection of these members, metal blocks 47 and 55 compress rubber pads 67 and 66. Metal pads 54 and 65 function to prevent angles 52, 53 from contacting support 46 and angles 61, 62 from contacting supported member 45 until pads 66 and 67 are fully compressed. Vertical movement downwardly ceases when the vertical legs of angles 52, 53, 61, and 62 contact the horizontal surfaces of members 45 and 46. Vertical deflections upwardly set up shear stresses in members 50, 51, 59, and 60 until further upward movement is prevented by the heads of bolts 70 and 71 contacting metal plate 63.

It is thus seen that my invention provides a cushion mounting in which, by proper selection of the mass of the elements of the mounting and the use of resilient elements in shear, the resonant frequency of the mounting is adjusted to a value lower than that of the lowest frequency in the range of vibrations to which the mounting is subjected. The cushion mounting further provides means for initially absorbing all deflecting forces by the setting up of shear stresses in certain of the resilient elements and, after initial deflection of these elements, by causing other resilient elements to be compressed. In this manner any secondary shocks to the system which would occur through sharp discontinuity of the resisting force are avoided.

While I have shown a particular embodiment of my invention, it will of course be understood that I do not wish to be limited thereto since various modifications may be made, and I contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A cushion mounting for a member supported by means subject to undesirable vibrations comprising, a pair of transverse resilient members interposed between said member and said supporting means, said resilient members being

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mounted to set up shearing stresses opposing forces applied thereto along three mutually perpendicular axes, and means responsive to predetermined longitudinal deflections of one of said resilient members to produce lateral deflections of the other of said resilient members, said last means comprising a rigid structure attached to both of said resilient members, said rigid structure being arranged to contact said supported member after said predetermined deflections and to compress said other resilient member between said rigid structure and said supporting means.

2. A cushion mounting for a member supported by means subject to undesirable vibrations comprising, a pair of transverse resilient members interposed between said member and said supporting means, means to limit vertical deflections of each of said resilient members comprising a rigid structure attached to both of said resilient members and arranged to contact both said supported member and said supporting means after predetermined vertical deflections of said resilient members, and means attached to said structure to produce lateral deflections of one of said resilient members after a predetermined longitudinal deflection of the other of said resilient members.

3. A cushion mounting for a member supported by means subject to undesirable vibrations comprising, a pair of transverse resilient members interposed between said member and said supporting means, and means responsive to predetermined longitudinal deflections of either of said resilient members to produce lateral deflections of the other of said resilient members, said last means comprising a rigid structure attached to both of said resilient members, said structure being arranged to contact said supported member after said predetermined deflections to compress said other resilient member between said rigid structure and said supporting means.

4. In a cushion mounting for a supported member, the combination of a first resilient means attached to said member, said means extending in a direction parallel with said member and being subjected to shear stresses by forces acting on said member in said direction, a second resilient means mechanically connected to said first means and extending in a second direction transverse to said first direction, said second means being subjected to shear stresses by forces acting on said member in said transverse direction, and limiting means attached to each of said resilient means whereby when the deflection of one of said resilient means due to said shear stresses equals a predetermined value the other of said resilient means is subjected to compressional stresses, both of said resilient means being subjected to shear stresses by forces acting on said member in a direction transverse to said first and second directions.

5. A cushion mounting for a member supported by means subject to undesirable vibrations comprising, a pair of transversely disposed channel shaped members, one of said channel members being fastened to said supported member and the other of said channel members being fastened to said supporting means, resilient means attached along the sides of each of said channel members, substantially rigid connecting means interposed between said resilient means, and means responsive to a predetermined longitudinal deflection of either of said resilient means to produce a lateral deflection of the other of said resilient means.

6. In a support, the combination of a pair of

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transversely disposed channel shaped members, a substantially rigid member positioned between said channel shaped members, resilient means attached along the sides of each of said channel members and connected to said substantially rigid member, said resilient means being mounted to set up shearing stresses opposing forces applied to said channel members along three mutually perpendicular axes, means responsive to a predetermined longitudinal deflection of either of said channel members to produce a lateral deflection of the other of said channel members, said last means including means to limit the motion of said channel members along each of said axes.

7. A cushion mounting for a member supported by means subject to undesirable vibration comprising a pair of transverse resilient members interposed between said member and said supporting means, a substantially rigid connecting means interposed between said resilient members, said resilient members being mounted to set up shearing stresses opposing forces applied to said supported member along three mutually perpendicular axes, and means responsive to a predetermined longitudinal deflection of one of said

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resilient members for producing compression of the other of said resilient members, said last means comprising rigid overlapping members positioned on opposite sides of said one resilient means for directly contacting said supported member after said predetermined deflection.

8. In a support, the combination of a pair of transversely disposed channel shaped members, resilient means attached along the sides of each of said channel members, substantially rigid connecting means interposed between and connected to said resilient means, said resilient means being mounted to set up shearing stresses opposing forces applied to said channel members along three mutually perpendicular axes, said connecting means including rigid members parallel with and partially co-extensive with said channel members, the points of connection of said resilient means to said connecting means being greater than the distance between said channel members and said connecting means whereby the setting up of substantial tension stresses in said resilient means is prevented.

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