(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: 0 156 387
A2

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: 85103706.9

(22) Date of filing: 27.03.85

(51) Int. Cl.[4]: B 25 F 5/02
B 25 G 1/02

(30) Priority 30.03.84 JP 61026/84
31.03.84 JP 64136/84

(43) Date of publication of application:
02.10.85 Bulletin 85/40

(84) Designated Contracting States:
CH DE FR GB LI NL SE

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(54) **Vibration-proof grip device.**

(57) A vibration-proof grip device is disclosed, which includes a first mass body coupled to a source of vibrations such as a machine drill, a leg drill, a pitching hammer, etc. via a first elastic member made of rubber or the like. A cylindrical grip member is mounted on the first mass body via a second elastic member made of rubber or the like A second mass body is mounted on the grip member, and an impact mass body is provided in the grip member such that it can strike the inner walls of the grip member. Vibrations transmitted from the vibration source are attenuated by the first elastic member, but the first mass body still is vibrated substantially at the same phase as the original vibrations of the vibration source The modulus of elasticity of the first and second elastic members and/or mass of the first and second mass bodies and impact mass body may be suitably selected such that the grip member, to which vibrations are transmitted from the first mass body, constitutes a node of vibrations, i.e., it is vibrated at the opposite phase to the first mass body. When the vibration frequency of the vibration source varies, the collision of the impact mass body has an effect of attenuating resultant vibrations of the grip member.

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Croydon Printing Company Ltd

TITLE OF THE INVENTION

VIBRATION-PROOF GRIP DEVICE

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to vibration-proof grip devices and, more particularly, to a vibration-proof grip device which can be suitably used as a grip for hand-supported vibratory tools or machines such as machine drills, leg drills, pitching hammers and disk grinders.

Description of the Prior Art

With recent increased use of hand-supported vibratory tools such as machine drills, leg drills, pitching hammers and disk grinders, vibrations that are produced when these tools are operated are posing labor sanitation problems. Various vibration-proof grips have been proposed to solve the problems noted above. Prior art vibration-proof grips mostly utilize vibration-proof rubber or springs which are provided between the tool as the source of vibrations and grip. The aim of such vibration-proof grips is to provide a vibration-proof effect of the grip by making the proper vibration frequency of the grip system to be lower than the vibration frequency of the tool body. In order to improve the vibration-proof performance of this system by increasing the vibration-proof effect, however, it is necessary to increase the weight of the grip or employ softer vibration-proof rubber or springs of smaller moduli of elasticity. Therefore, it has been impossible to attain the weight reduction and improve operability (i.e., mechanical strength) desired for the grip of this kind at the same time.

SUMMARY OF THE INVENTION

The present invention has been intended to effectively solve the prior art problems noted above and its object is to provide a vibration-proof grip device to be used as a grip for a tool or machine producing undesired strong vibrations, which can provide sufficient vibration-proof effect and also permits a mechanical strength practically equal to that of a rigid support and reduction of size and weight to be realized.

The invention is predicated on a fact that one or more nodes of vibrations occur in a vibration system, having a multiple freedom, in which a plurality of mass bodies are coupled to one another via elastic members such as rubber members, when the system is vibrated. According to the invention, the center of a grip member is located at a position, at which a node of vibrations occurs. In addition, an impact mass body is provided in the grip member such that it can strike the grip member that would arise due to variations of the vibration frequency of the vibration source.

More specifically, according to the invention there is provided a vibration-proof grip device, which comprises a first mass body mounted on a source of vibrations via a first elastic member made of rubber or the like, a grip member mounted on the first mass body via a second elastic member made of rubber or the like, a second mass body mounted on the grip member, and an impact mass body provided in the grip member such that it can strike the inner walls of the grip member.

According to the invention there is also provided a vibration-proof grip device, which comprises a pair of mass bodies mounted on a source of vibrations via respective first elastic members made of rubber or the like, a pair of rods extending from the respective mass bodies toward each other, second elastic members made of rubber or the like and each mounted on the outer periphery of each rod, a cylindrical grip member connecting the two second elastic members, and an impact pass body provided in the grip member between the two rods.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a front view showing a first embodiment of the vibration-proof grip device according to the invention;

Fig. 2 is a longitudinal sectional view showing a mounting portion of the embodiment of Fig. 1 which is coupled to a source of vibrations;

Fig. 3 is a longitudinal sectional view, to an enlarged scale, showing a grip portion of the device shown in Fig. 1;

Fig. 4 is a graph showing vibratory acceleration transmitted to a prior art machine drill grip;

Fig. 5 is a graph showing vibratory acceleration transmitted to an end of grip member of the embodiment of the device shown in Fig. 1 mounted on the same machine drill;

Fig. 6 is a front view, partly in section, showing a second embodiment of the invention;

Fig. 7 is a graph showing vibratory acceleration transmitted to a prior art leg drill grip;

Fig. 8 is a graph showing vibratory acceleration transmitted to a center of grip member of the embodiment shown in Fig. 6 mounted on the same leg drill;

Fig. 9 is a front view, partly in section, showing a third embodiment of the invention;

Fig. 10 is a graph showing vibratory acceleration transmitted to a prior art pitching hammer grip;

Fig. 11 is a graph showing vibratory acceleration transmitted to an end of grip member of the embodiment shown in Fig. 9 mounted on the same pitching hammer;

Fig. 12 is a longitudinal sectional view showing a different example of an impact mass body according to the invention;

Fig. 13 is a front view, partly in section, showing a further embodiment of the vibration-proof grip device according to the invention;

Fig. 14 is a graph showing vibratory acceleration transmitted to a prior art pitching hammer grip;

Fig. 15 is a graph showing vibratory acceleration transmitted to a grip member of the embodiment shown in Fig. 13 mounted on the same pitching hammer;

and

Fig. 16 is a front view, partly in section, showing a further example of the impact mass body according to the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Now, preferred embodiments of the invention will be described with reference to the accompanying drawings.

Referring to Fig. 1, there is shown a first embodiment of the invention. Reference numeral 1 designates a tubular body which is mounted on a source of vibrations such as a machine drill. Filling the tubular body 1 is a first elastic member 2, as shown in Fig. 2, which is a cylindrical member made of rubber and is secured by baking to the tubular body 1. Pair nuts 3 are coaxially inserted in and secured to opposite end portions of the first elastic member 2. Each nut 3 has a bottom, and its inner periphery is formed with a female thread. Screwed in each of the nuts 3 is a stem portion 4a of a first mass body 4 having a rod-like shape, as shown in Fig. 3. A portion 4a of the first mass body 4 other than its stem portion 4a is buried in a second elastic member 6 made of rubber, which fills a stem portion of a cylindrical grip member 5. The portion 4b of the first mass body 4 has flanges 4c which serve to prevent detachment of the portion 4b from the second elastic member 6.

The grip member 5 has a central partition wall 5a and has an open end opposite the second elastic member 6. A second mass body 7 is mounted in the open end of the grip member 5 to close the opening.

The grip member 5 has an inner space 8 which is defined between the partition wall 5a and second mass body 7, and a substantially cylindrical impact mass body 9 is provided in the space 8. The radial dimension of the impact mass body 9 is slightly smaller than the inner diameter dimension of the grip member 5, and also its axial dimension is slightly smaller than the axial dimension of the space 8 between the second mass body 7 and the partition wall 5a. The impact mass body 9 is capable of being vibrated in the space 8 and striking the inner wall of the grip member 5 and second mass body 7.

The operation of this embodiment will now be described.

Undesired vibrations are transmitted from the source of vibrations such as machine drill to the tubular body 1. The vibrations transmitted to the tubular body 1 is attenuated by the first elastic member 2 to a certain extent before being transmitted to the opposite side first mass bodies 4. The first mass bodies 4 are vibrated substantially at the same phase as the original vibrations. The vibrations of each first mass body 4 are transmitted through the second elastic member 6 to the grip member 5. It should be noted that in this embodiment the second elastic member 6 intervenes between the first mass body 4 and stem portion of the grip member 5 and the second mass body 7 and impact mass body 9 are provided on the other side of the grip member 5 than the stem side and serve to suppress vibrations or displacement by their inertia. The elasticity of the second elastic member 6, the mass of the second mass body 7 and impact mass body 9 and/or the length of the grip member 5 may be suitably selected such that the other side of the grip member 5 than the stem side, the vibrations of which lags behind the vibrations of the first mass body 4, will vibrate at the opposite phase to and at the same frequency as the first mass body 4. In this case, the first mass body 4 which is vibrated with the original vibrations constitutes a loop of vibrations, while the end portion of the grip member 5 other than the stem thereof constitutes a node of vibrations. The original vibrations from the source of vibrations thus can be extremely attenuated. Actually, the end portion of the grip member 5 is not substantially vibrated.

A vibration mode, in which the first mass body 4 constitutes a loop of vibrations and the end portion of the grip member 5 constitutes a node of vibrations, is actually obtained in a comparatively narrow frequency range. With an actual vibrating tool, however, deviations from a given vibration frequency to some extents is inevitable due to such case as load variations. For this reason, it is sometimes a case that the vibration mode noted above fails to be realized so that the end portion of the grip member 5 is vibrated. According to the invention, the impact mass body 9 provided in the grip member 5 can provide a vibration-proof effect for a considerably wide vibration frequency range.

More specifically, in case when the end portion of the grip member 5 is vibrated due to variations of the frequency of the original vibrations of the vibration source, the impact mass body 9 in the space 8 is vibrated at a different phase from the vibration phase of the grip member 5, so that it strikes the walls of the grip member 5 including the partion wall 5a and also the second mass body 7. Such collision of the impact mass body 9 have an effect of suppressing or attenuating the vibrations of the end portion of the grip member 5. Thus, the vibrations of the end portion of the grip member 5 can be effectively prevented over a comparatively wide vibration frequency range of the vibration source. In this case, the gap or clearance between the outer periphery of the impact mass body 9 and inner periphery of the grip member 5 should be appropriately set, preferably to about 0.5 mm. If the clearance is too small, the impact mass body 9 and grip member 9 would be vibrated in unison with each other, so that a vibration attenuation effect due to the collision of the impact mass body 9 can not be obtained. On the other hand, if the clearance is too large, the frequency of collision of the impact mass body 9 would be too low to suppress the vibrations of the grip member 5.

Fig. 4 shows results of measurement of vibratory acceleration transmitted to a prior art grip of a machine drill, while Fig. 5 shows results of measurement of vibratory acceleration transmitted to the end portion of the grip 5 of this embodiment of the vibration-proof grip device when the device is mounted on the same machine drill. In Figs. 4 and 5, the ordinate is taken for gravitational acceleration, and the abscissa is taken for time. With the vibration-proof grip device according to the invention undesired strong vibrations transmitted to the grip can be greatly attenuated to very weak vibrations. This vibration-proof effect is recognized with respect to vibration components of the grip member 5 both in the radial and axial directions.

Fig. 6 shows a second embodiment of the vibration-proof device according to the invention.

Referring to the figure, reference numeral 10 designates a plate-like member which is mounted by bolts on a vibration source such as a leg drill. Pair tubular bodies 11 are mounted on the opposite bent ends of the plate-like member 10. A cylindrical grip member 13 central portion of which is somewhat expanded is provided between the pair tubular bodies 11 in a coaxial relation thereto. The tubular bodies 11 are each filled with a first elastic member 12 made of rubber. Opposite end portions of the grip member 13 are filled with second elastic members 14 made of rubber. The grip member 13 is supported by first mass bodies 15, each of which bridges the associated first and second elastic members 12 and 14. An inner end portion of each first mass body 15 is buried in and secured to the associated second elastic member 14. An outer end portion of each first mass body 15 penetrates the first elastic member 12, and a lock nut 16 is fitted on its outer end projecting from the associated first elastic member 12. A sleeve 19 is provided in the see-through hole of the first elastic member 12 which is penetrated by the first mass body 15. The grip member 13 has a pair of partition walls 13a defining a central inner space. An impact mass body 18 is provided in the central inner space. The radial dimension of the impact mass body 18 is slightly smaller than the inner periphery diameter of the wall of the grip member 13 defining the central inner space so that the impact mass body 18 can strike the inner wall of the grip member 13.

Vibrations of a vibration source are transmitted through the plate-like member 10 and each tubular body 11 to each first elastic member 12 to be attenuated therein before being transmitted to each first mass body 15. The first mass body 15 undergoes vibrations substantialy at the same phase and at the same frequency as the original vibrations although with a smaller amplitude than the original vibrations. The first mass bodies 15 are vibrated comparatively strongly, but by virtue of the presence of the second elastic member 14 and impact mass body 18, a central portion of the grip member 13 is vibrated at the opposite phase to the vibrations of the first mass bodies 15, that is, it constitues a node of vibrations. In other words, the central portion of the grip member 13 is not substantially vibrated, and a sufficient vibration-proof effect can be obtained. The second mass bodies 17 in this embodiment are thought to serve as inertial mass to suppress vibrations transmitted from the end portion of the first mass bodies 15 through the second elastic members 14 to the ends of the grip member 13. The vibration suppression effect of the collision of the impact mass body 18 is the same as in the preceding first embodiment.

Fig. 7 shows results of measurement of vibratory acceleration transmitted to a prior art grip mounted on a leg drill, while Fig. 8 shows results of measurement of vibratory acceleration transmitted to the central portion of the grip member 13 of this embodiment of the vibration-proof grip device which is mounted on the same leg drill. Again with this embodiment very satisfactory vibration-proof effects are recognized.

Fig. 9 shows a third embodiment of the vibration-proof grip device according to the invention. Referring to the figure, reference numeral 20 designates a cylindrical member with a bottom, which is mounted on a vibration source such as a pitching hammer. The cylindrical member 20 also serves as a compressed air source section for supplying working compressed air to the vibratory tool body. Compressed air is supplied to the cylindrical member 20 through a tube 21 mounted on a side wall of the member 20. The tube 21 is curved and serves as a grip support. A cylindrical grip member 23 is mounted on an end portion of the tube 21 via an elastic member 22 made of rubber. An impact mass body 24 is provided in an end portion of the grip member 23 such that it can strike the grip member 23. The grip member 23 is provided at the end with a connector 25, to which an air supply hose can be connected. An on-off valve 26 is provided on a portion of the tube 21 extending between the cylindrical member 20 and grip member 23, and it can open and close a compressed aiar passage. The on-off valve 26 includes a valve member 27 having a see-through hole, a spring 29 urging the valve member 27 against a valve casing 28 and a lever 30 for operating the valve member 27. The impact mass body 24 has a see-through hole serving as a compressed air passage. In this embodiment, the curved tube 21 has flexibility so that it can serve the roles of both the first mass body and the first elastic member. Vibrations of the source of vibrations are transmitted through the cylindrical member 20 to the tube 21. Owing to the presence of the elastic member 22 and impact mass body 24, however, a node of vibrations is formed at the end portion of the grip member 23 to provide for the vibration-proof effect. The collision of the impact mass body 24 also provides a vibration suppression effect.

Fig. 10 shows results of measurement of vibratory acceleration transmitted to a prior art grip mounted on a pitching hammer, while Fig. 11 shows results of measurement of vibratory acceleration transmitted to the end of the grip member 23 of this embodiment of the vibration-proof grip device which is mounted on the same pitching hammer. Again with this embodiment, excellent vibration-proof effects could be recognized.

In the above embodiments the impact mass bodies 9, 18 and 24 have each been a one-piece body, but it is possible to replace the one-piece body with a plurality of washers or steel balls.

Fig. 12 shows a modification of the first embodiment, which employs a plurality of washers 31 in lieu of the impact mass body 9. In this case, the individual washers 31 will randamly collide with one another, so that it is possible to improve the vibration-proof effect.

Fig. 13 shows a further embodiment of the vibration-proof grip device according to the invention. Referring to the figure, reference numeral 41 designates a vibration source which produces undesired vibrations, e .g., a pitching hammer, a disk grinder, a hammer drill and other vibratory tools.

A plate-like support 42, on which the embodiment of the vibration-proof grip device is mounted, is secured by bolts to the vibration source 41. The plate-like support 42 has a pair of cylindrical casings 43 which are provided symmetrically at its opposite ends. Shafts 44 coaxially penetrate the respective casing 43. A portion of each shaft 44 that extends in the associated casing 43 has a flange 44a. Two first elastic members 45 made of rubber fill the space between the outer periphery of the shaft 44 and inner periphery of the casing 43 such that the flange 44a is found between and supported by these elastic members 45. The first elastic members 45 permit vibrations of the shaft 44 in the axial direction of the casing 43. Rings 46 are provided to prevent wear of the shaft 44 and shaft holes of the casing 43 due to contact of the two when the shaft 44 is vibrated.

A pair of arms 47 are mounted on opper end portions of the respective shafts 44. The arms 47 are symmetrically outwardly curved so that they respectively have substantially semi-circular arcular shape. They have respective flanges 47a provided at the end and facing each other. Each of the arms 47 has a cylindrical stem portion 47b, which is fitted on a reduced-diameter upper end portion 44b of the shaft 44 and secured by a bolt 48 to the shaft 44. Pair rods 49 extend from the flanges 47a at the end of the pair arms 47 toward each other. These rods 49 are coaxially aligned to each other. Second elastic members 50 made of rubber are each mounted on the outer periphery of each rod 49. A cylindrical grip member 51 encloses and couples together the two second elastic memers 50. A space is defined in the grip member 51 between the two rods 49 or two second elastic members 50, and a cylindrical impact mass body 52 is provided in this space. The outer diameter of the impact mass body 52 is slightly smaller than the inner diameter of the grip member 51, and also its axial dimension is slightly smaller than the axial dimension of the space between the two rods 49 or second elastic members 50. The impact mass body 52 is capable of striking the grip member 51, rods 49 and second elastic members 50. Rivets 53 are provided for preventing the rotation of the grip member 51 relative to the rods 49. The rivets 53 are unnecessary in case where the second elastic members 50 and rods 49 are secured by baking to the grip member 51. In this embodiment, each shaft 44 and associated arm 47 constitute a mass body 54 which can be vibrated through the first elastic members 45.

The operation of this embodiment will now be described.

Undesired vibrations are transmitted from the vibration source 41 through the plate-like support 42 to the opposite end casings 43. The vibrations of each casing 43 are attenuated by the first elastic members 45 before being further transmitted to the mass body 54 consisting of the shaft 44 and arm 47. The vibrations of the mass body 54 are transmitted through the rod 49, second elastic member 50 and grip member 51 to the impact mass body 52.

The mass and dimensionsof the mass bodies 54 and impact mass body 52 and/or modullus of elasticity of the first and second elastic members 45 and 50 may be appropriately selected such that the mass bodies 54 will vibrate at the same frequency and the same phase as the vibration source 41 but the impact mass body 52 and grip member 51 will vibrate at the opposite phase to but at the same frequency as the vibrations of the mass bodies 54. That is, in this case the mass bodies 54 constitute a loop of vibrations, while the grip member 51 constitutes a node of vibrations. Thus, vibrations transmitted from the vibration source 41 are extremely attenuated and are substantially not transmitted to the grip member 51. Again with this embodiment a vibration suppression effect can be obtained over a considerably wide frequency range owing to the impact mass body 52. The clearance between the impact mass body 52 and grip member 51 is set to a predetermined value, e.g., about 0.5 mm. Again in this embodiment, if the clearance is too small, the impact mass body 52 and grip member 51 would be vibrated in unison with each other, so that the vibration attenuation effect due to the collision of the impact mass body 52 can not be expected. If the clearance is too large, on the other hand, the frequency of collision of the impact mass body 52 would be too low to be able to suppress vibrations of the grip member 51.

Fig. 14 shows results of measurement of vibratory acceleration transmitted to a prior art grip used for a pitching hammer, while Fig. 15 shows results of measurement of vibratory acceleration transmitted to the central portion of the grip member 51 of this embodiment of the vibration-proof grip device which is mounted on the same pitching hammer. As is obvious from Figs. 14 and 15, it is confirmed that with the vibration-proof grip device according to the invention undesired strong vibrations which are transmitted to the prior art grip of pitching hammer, are attenuated to very weak vibrations which cannot be substantially recognized. The vibration-proof effect can be recognized both in the radial and axial directions of the grip memer 51 like the preceding embodiments. In Figs. 14 and 15, the ordinate is taken for the graviatations acceleration, and the abscissa is taken for time.

The impact mass body 52 in the above embodiment may be replaced with a plurality washers or steel balls. In this case, the individual washers or steel balls will collide with one another, so that the overall motion or collision of the washers or steel balls which serve as the impact mass body is complicated, so that it is possible to improve the vibration-proof effect.

Fig. 16 shows a case, in which steel balls 60 are employed in lieu of the impact mass body 52 in the above embodiment. In this case, the extent, to which the steel balls fill the inner space of the grip member 51, is appropriately adjusted.

What is claimed is:

1. A vibration-proof grip device comprising:

a first mass body mounted on a source of vibrations via a first elastic member made of rubber or the like;

a grip member mounted on said first mass body via a second elastic member made of rubber or the like;

a second mass body mounted on said grip member; and

an impact mass body provided in said grip member such that it can strike the inner walls thereof.

2. The vibration-proof grip device according to claim 1, wherein said second mass body is mounted on an end of said grip member remote from said first mass body.

3. A vibration-proof grip device comprising:

a pair of first mass bodies mounted on a source of vibrations via respective first elastic members made of rubber or the like such that they extend outward each other.

a pair of grip members each mounted on each said first mass bodies via a second elastic member;

second mass bodies each mounted on each said grip member; and

impact mass bodies each provided in each said grip members such that they can strike the inner walls of said grip members.

4. The vibration-proof grip device according to claim 3, wherein each said second mass bodies is mounted on end of each said grip member remote from the associated said first mass body.

5. A vibration-proof grip device comprising:

a pair of first mass bodies mounted on a surce of vibrations via respective first elastic members made of rubber or the like such that they extend toward each other;

a grip member coupled between said first mass bodies via second elastic members made of rubber or the like;

a pair of second mass bodies provided in opposite ends of said grip member; and

an impact mass body provided in said grip member.

6. The vibration-proof grip device according to one of claims 1, 3, and 5, wherein the clearacne between said impact mass body or each said impact mass body and inner periphery of said grip member or each said grip member is about 0.5 mm.

7. The vibration-proof grip device according to one of claims 1, 3, and 5, wherein said impact mass body or each said impact mass body consists of a plurality of impact mass body pieces.

8. A vibration-proof grip device comprising:

a pair of mass bodies mounted on a source of vibrations via respective first elastic members made of rubber or the like;

a pair of rods extending from said respetive mass bodies toward each other;

second elastic members made of rubber or the like and each mounted on the outer periphery of each said rod;

a cylindrical grip member connecting said two second elastic members; and am impact mass body provided in said grip member between said two rods.

9. The vibration-proof grip device according to claim 8, wherein the clearance between said impact mass body and the inner periphery of said grip member is about 0.5 mm.

10. The vibration-proof grip device according to claim 8, wherein said impact mass body consists of a plurality of impact mass body pieces.

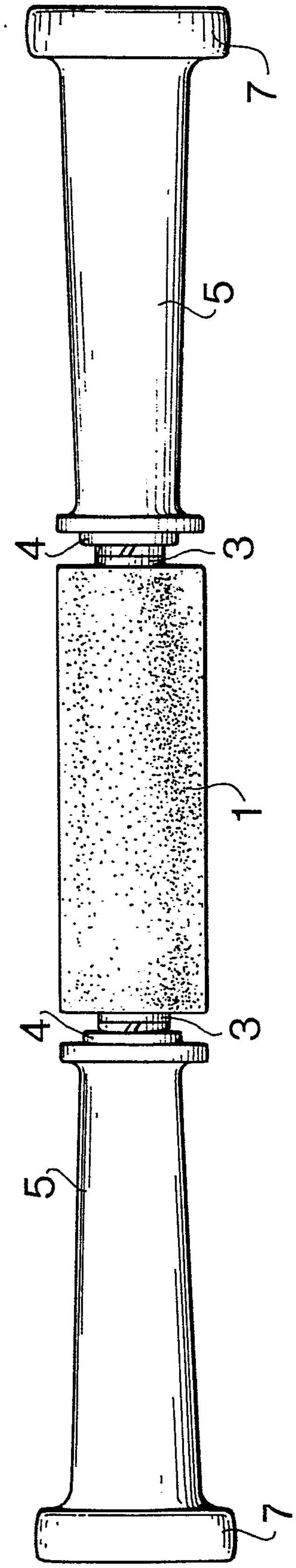


FIG.1

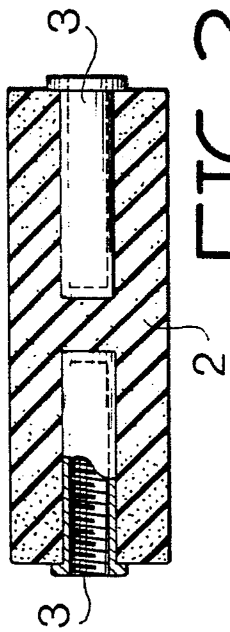


FIG.2

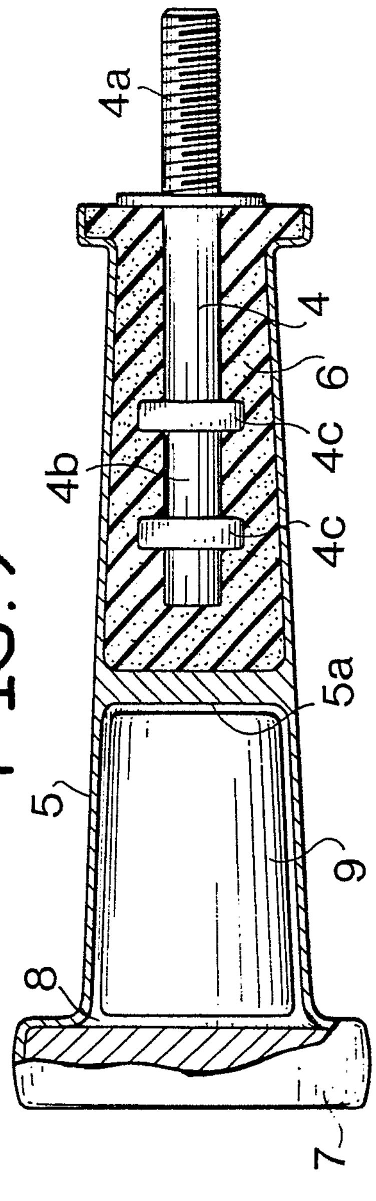


FIG.3

FIG.4

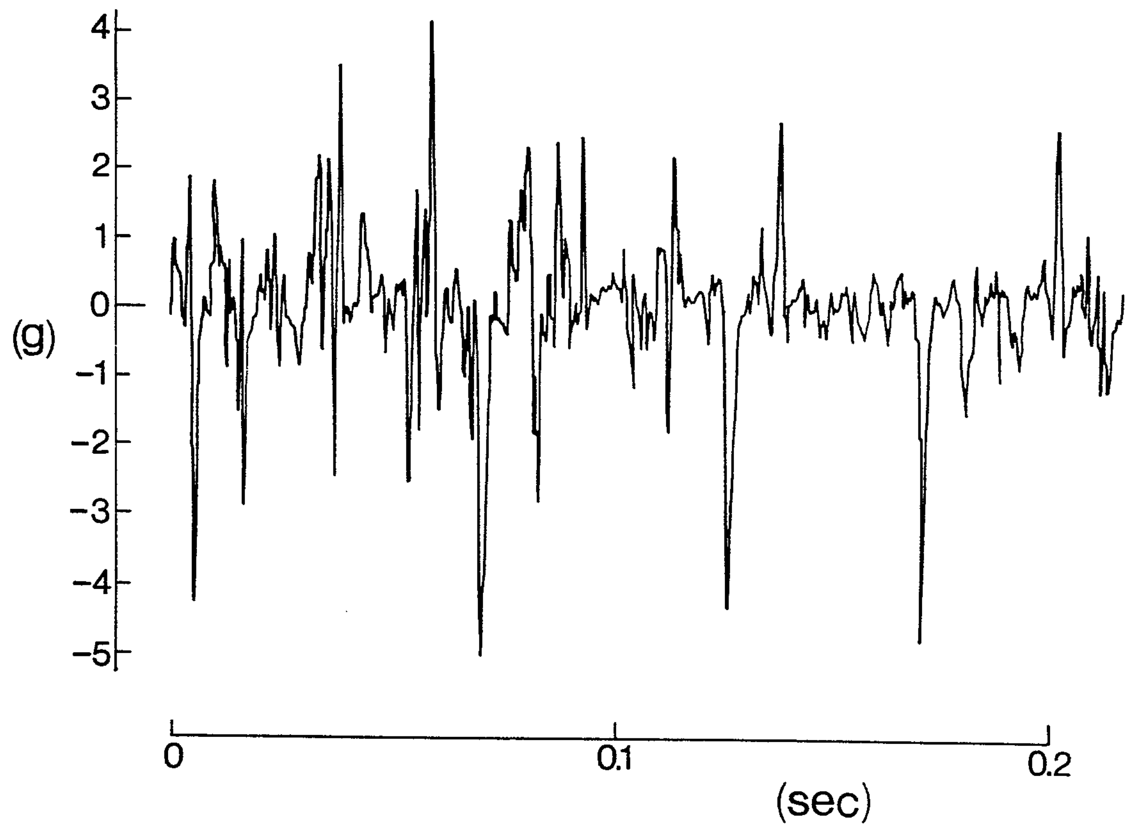


FIG.5

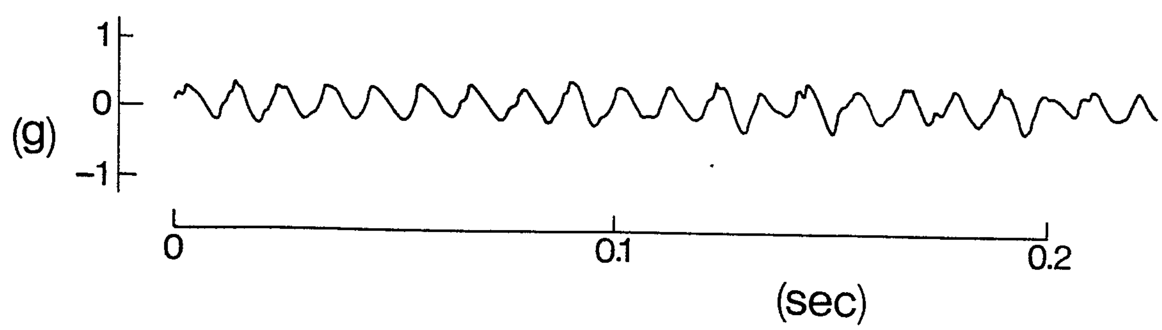


FIG.6

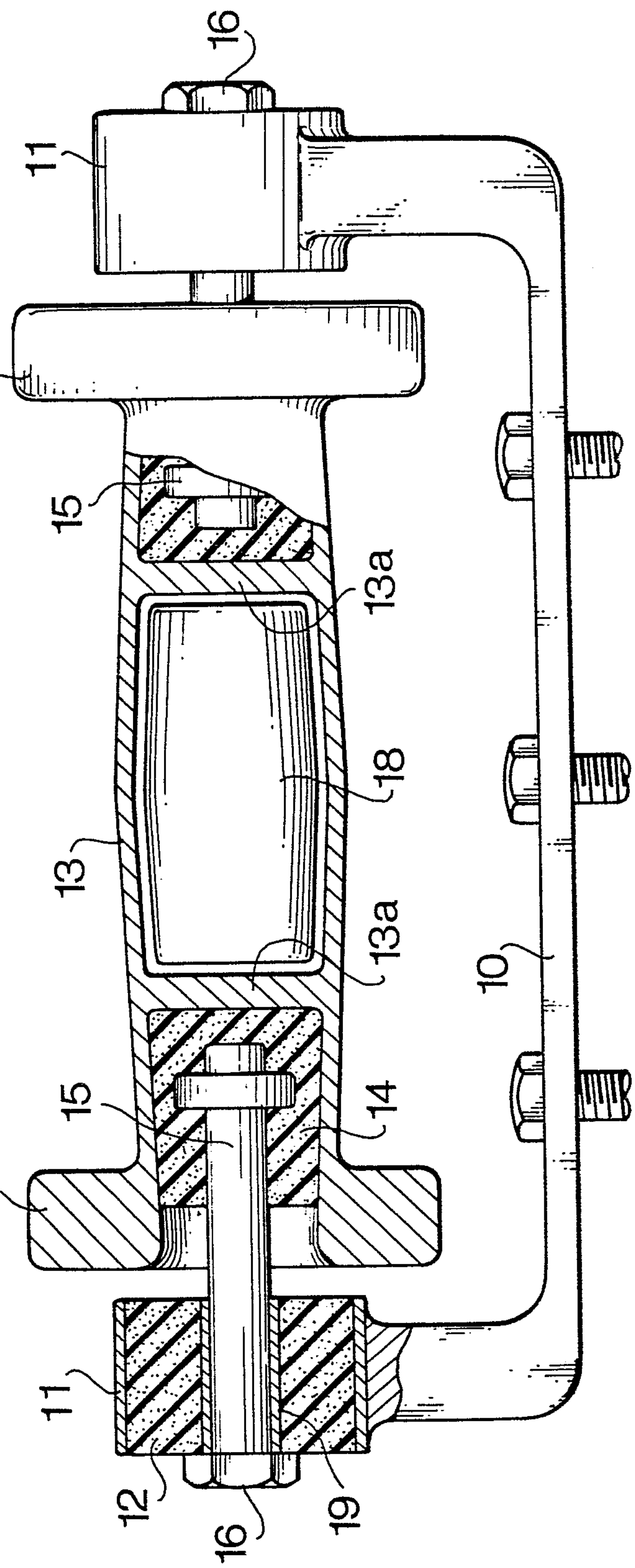


FIG.7

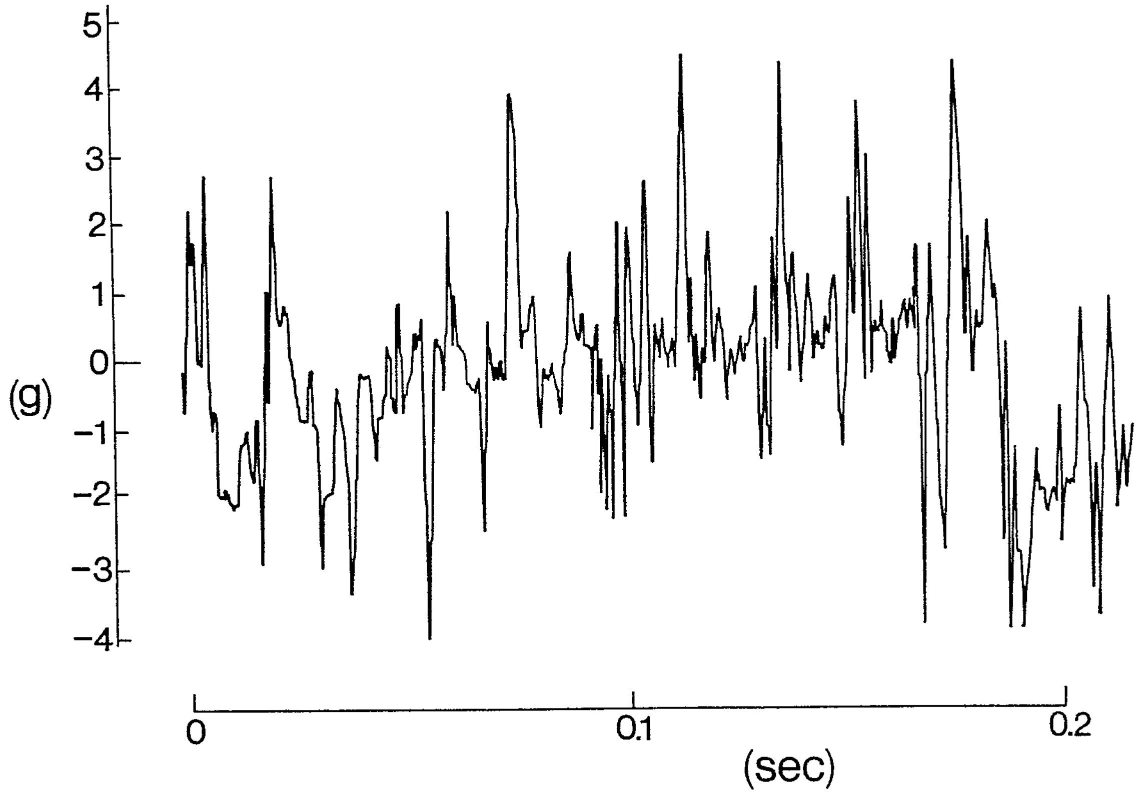
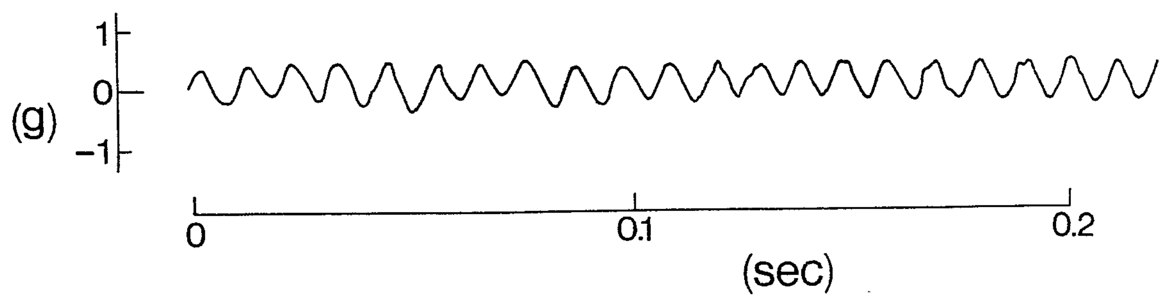


FIG.8



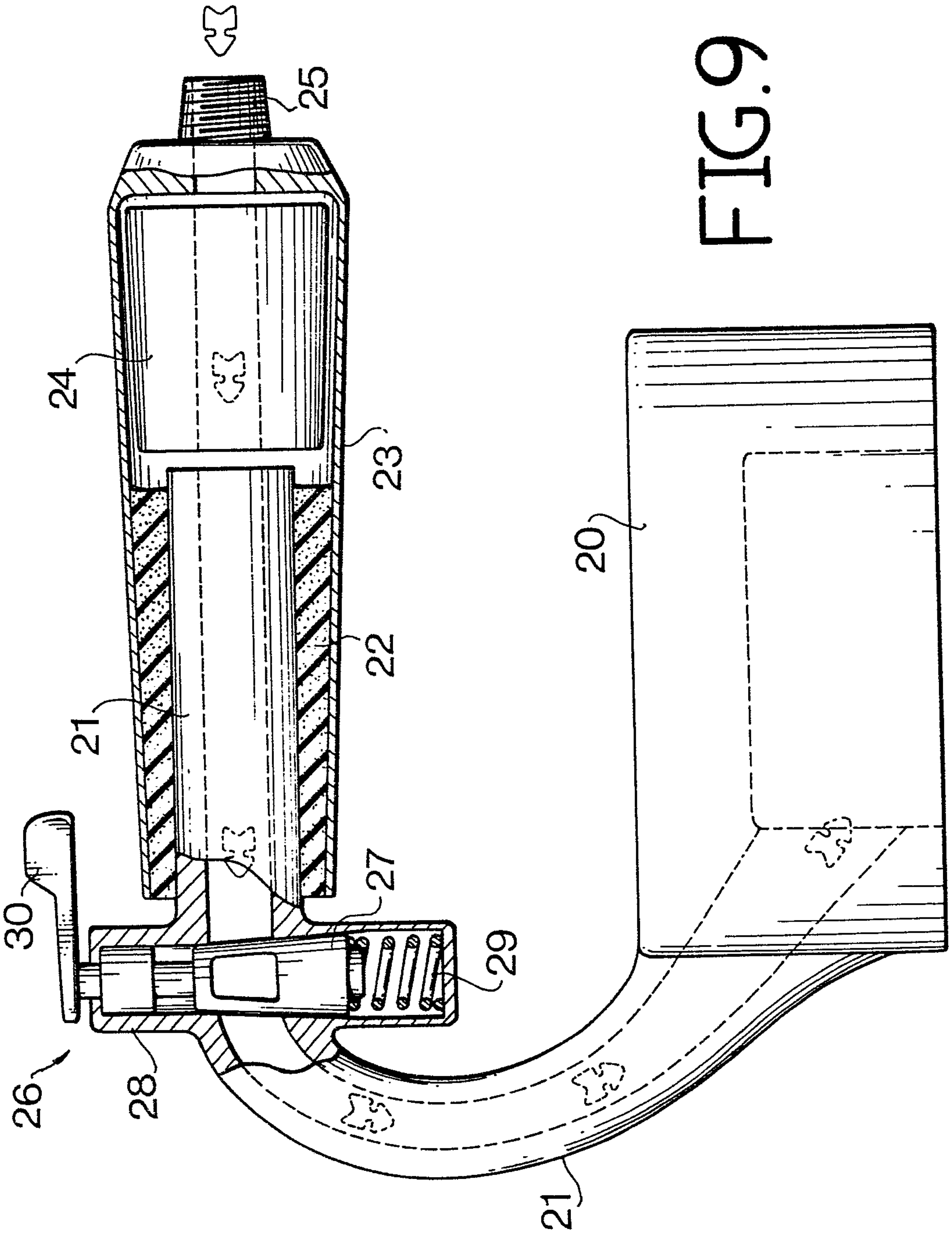


FIG.9

FIG.10

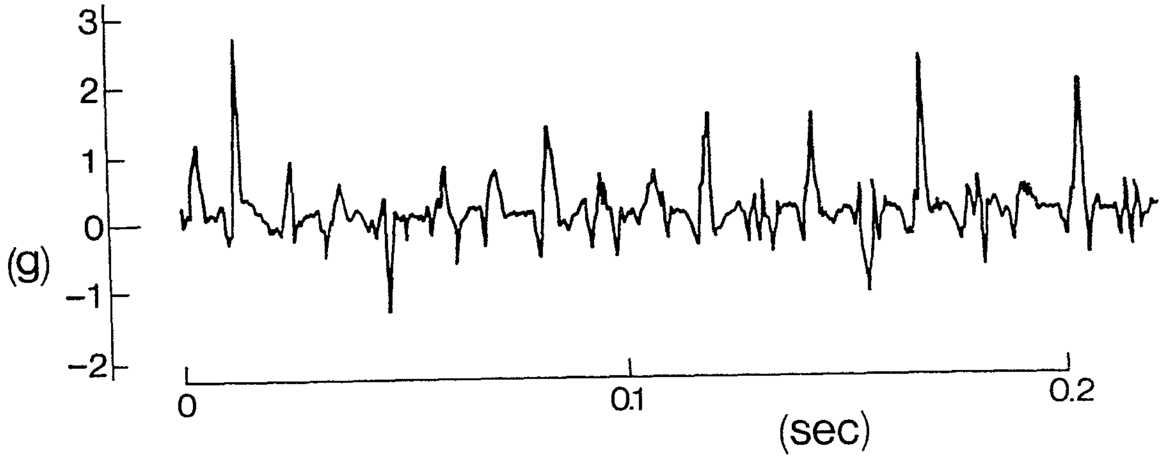


FIG.11

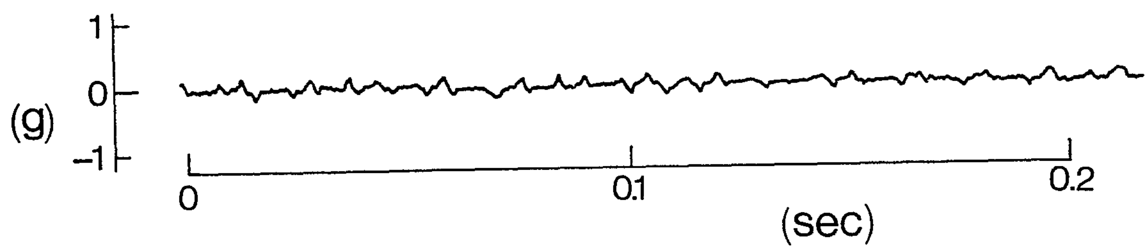
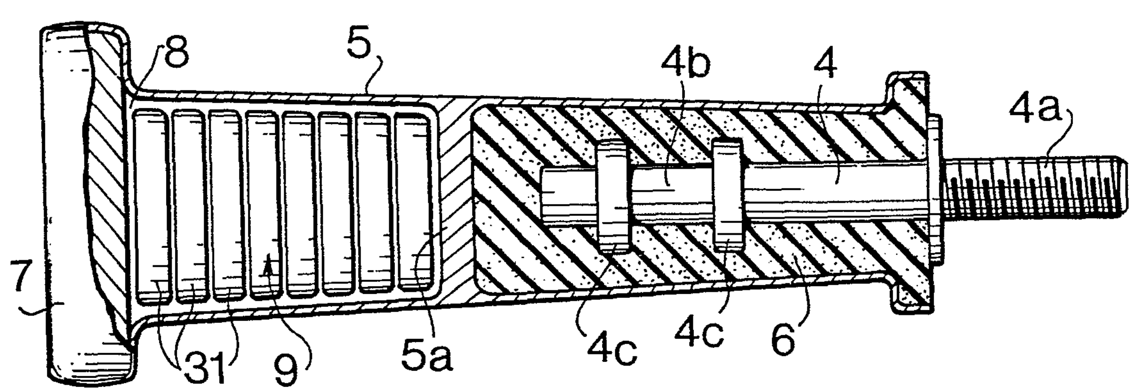


FIG.12



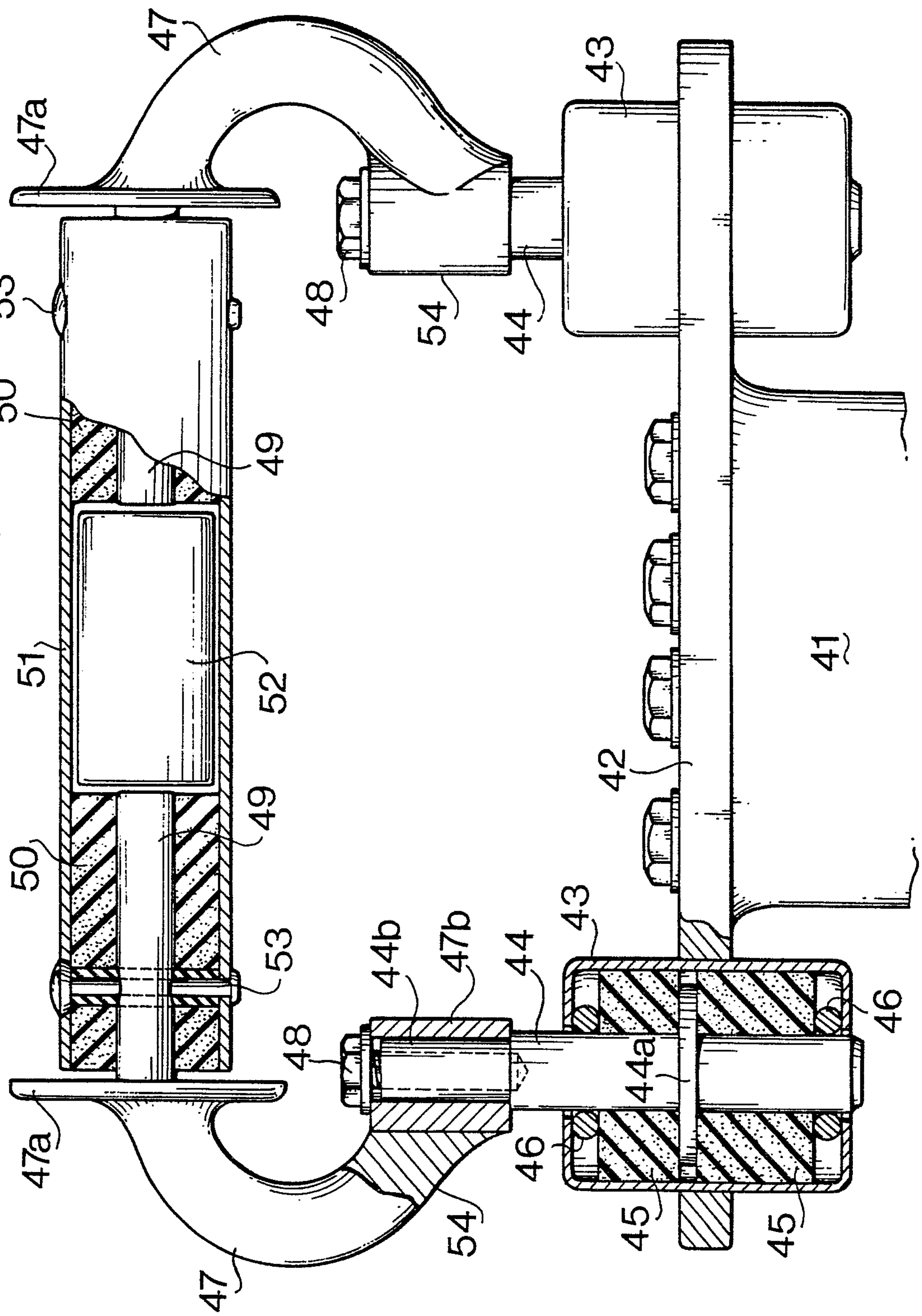


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FIG.13

FIG.14

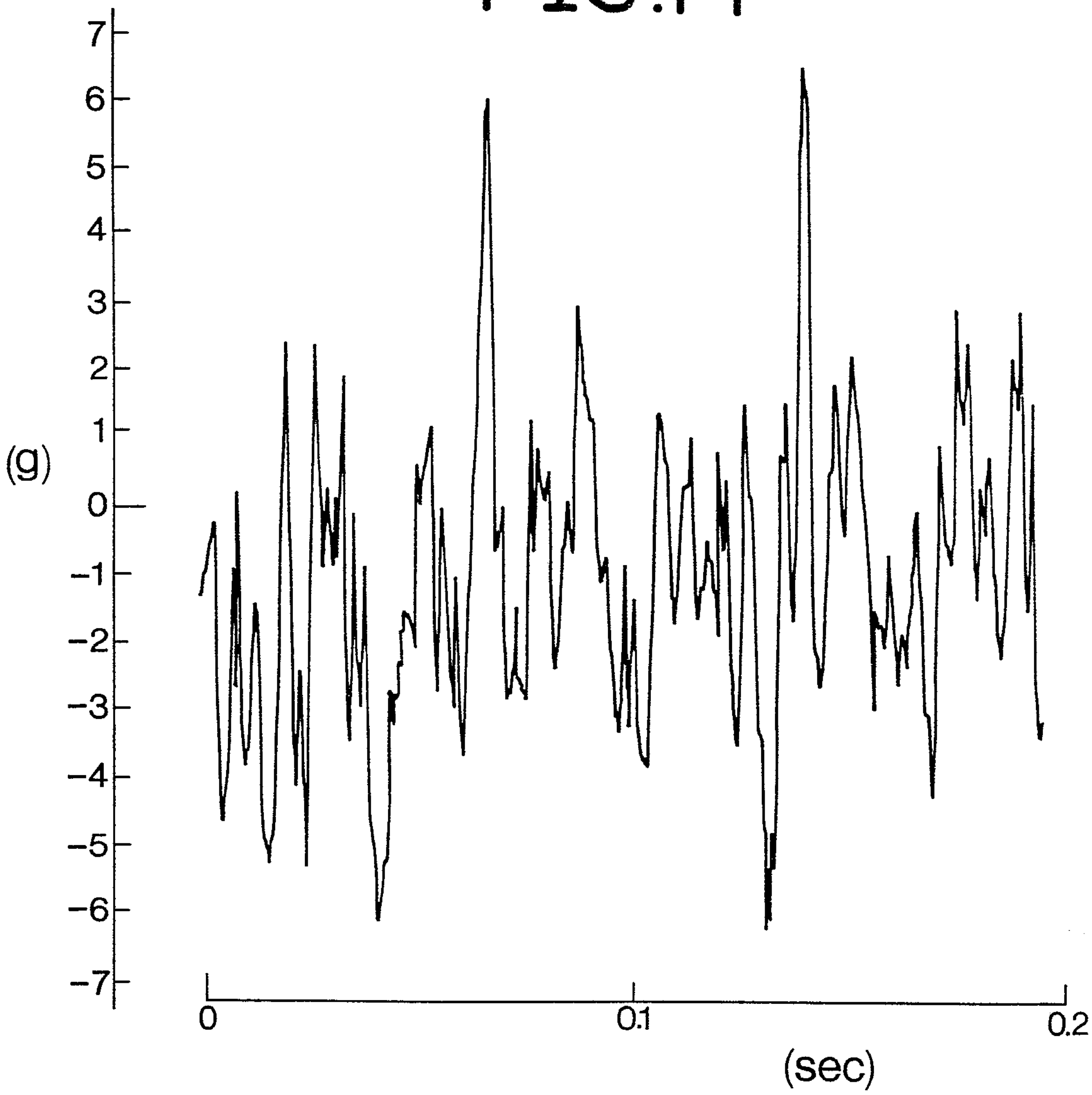


FIG.15

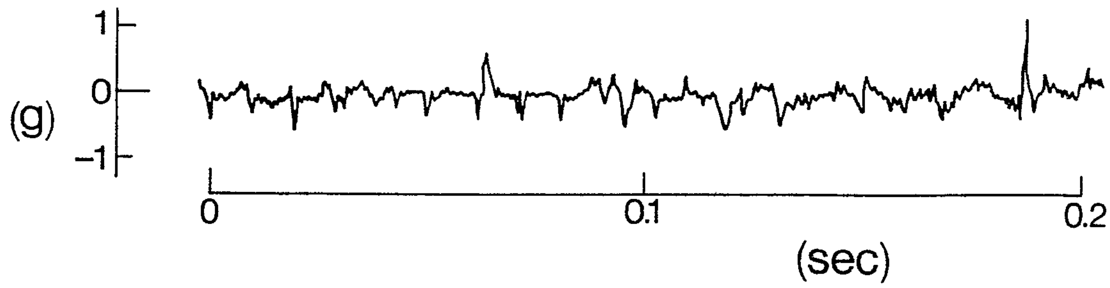
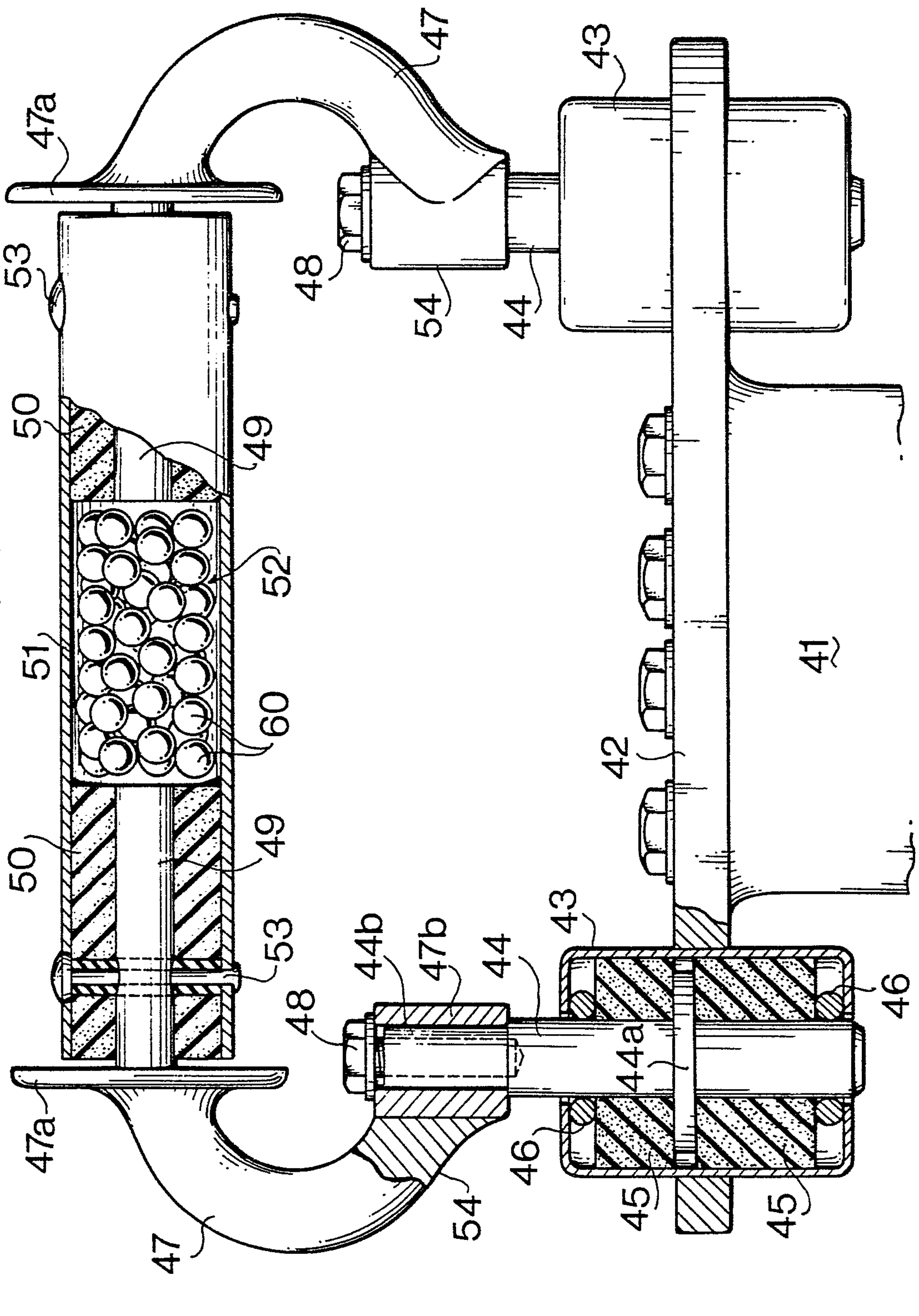


FIG.16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