April 13, 1965 A. H. PETERSON 3,177,953

VIBRATOR

Filed Oct. 23, 1961 2 Sheets-Sheet 1

FIG. 1

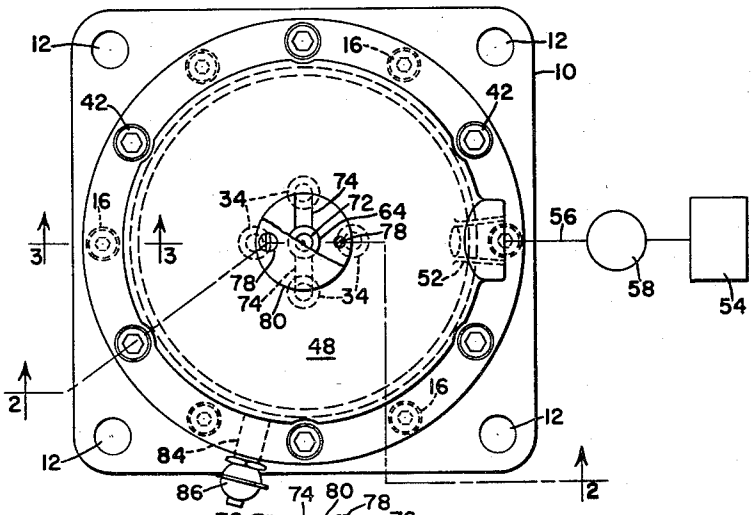


FIG. 3

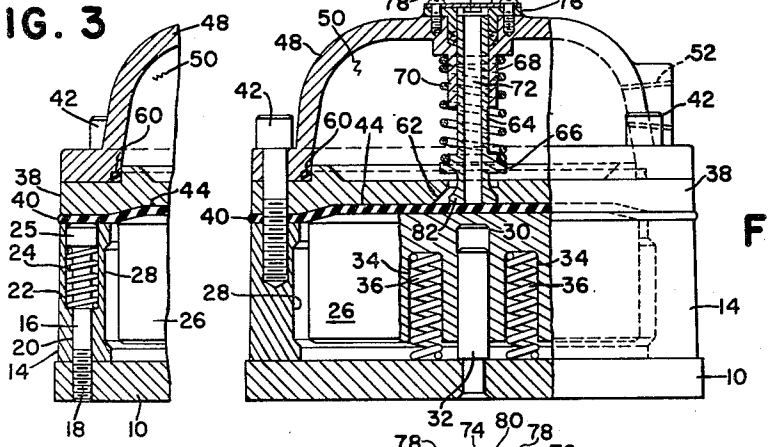
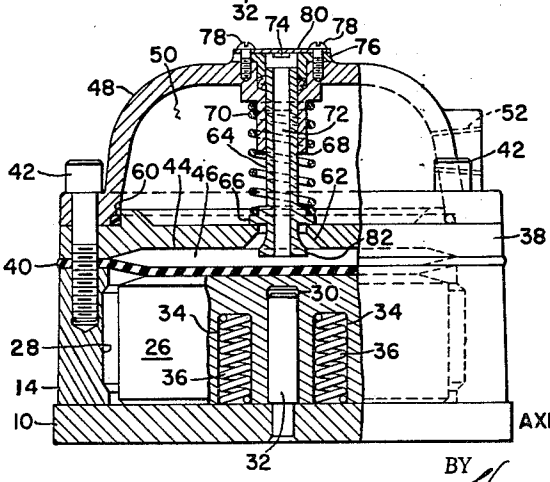


FIG. 2

FIG. 4



INVENTOR.
AXEL H. PETERSON

BY

ATTORNEY

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FIG. 5

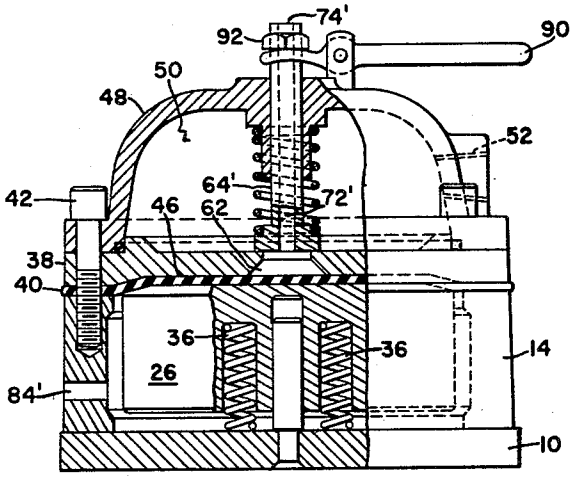


FIG. 6

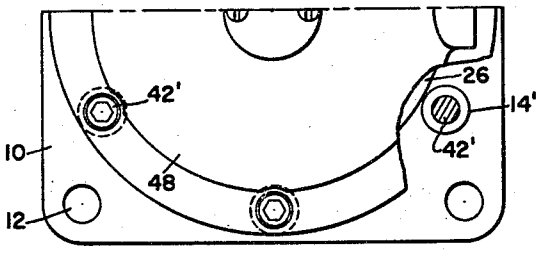


FIG. 7

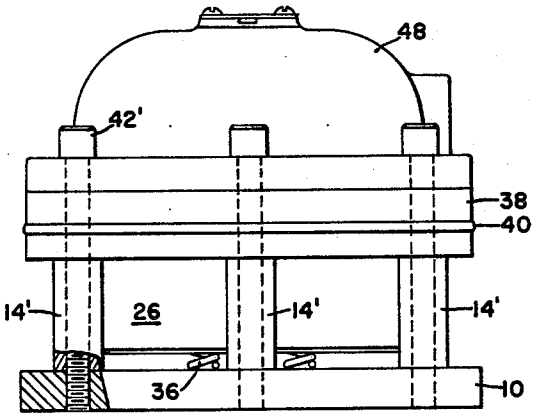
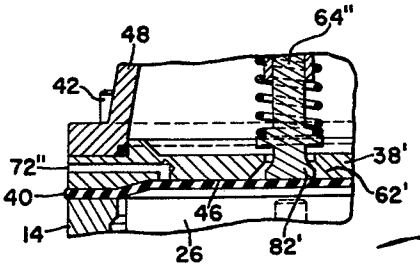


FIG. 8



INVENTOR.
AXEL H. PETERSON

BY

ATTORNEY

United States Patent Office 3,177,953 Patented Apr. 13, 1965

3,177,953

VIBRATOR

Axel H. Peterson, 4431 5th Ave., Rock Island, Ill.

Filed Oct. 23, 1961, Ser. No. 146,859
9 Claims. (Cl. 173—121)

This invention relates to a vibrator and more particularly to that type of mechanism in which the vibrating or shaking forces are obtained by impacting one member against another.

The principal object of the invention resides in the provision of a novel mechanism of the character referred to, relying mainly upon a simplified construction in which fluid pressure intermittently supplied to and released from a chamber causes the impacting or hammering forces to occur as a result of a reciprocating hammer or weight moving toward and away from or even striking and rebounding from a striker element or plate. It is a further object to incorporate this mechanism in a simple and compact structure which is adapted to be attached or otherwise connected to objects such as containers, hoppers etc. to facilitate the loading, unloading, settling and other forms of handling of materials. A subsidiary but nonetheless important object resides in the provision of such construction in which the impacting or vibratory forces are obtained automatically and continuously over any desired period as long as the pressure source is maintained effective. A further object resides in the adaptation of such construction to a device in which intermittent impacting forces are obtainable through a manual control which enables the operator to secure a single blow if desired, or any number of blows varied as to frequency.

A further object relates to the provision in such device of a simplified fluid-pressure receivable and -dischargeable chamber incorporating piston means in the form of a diaphragm in direct contact with the mass or hammer means, thereby eliminating complicated sealing problems. A further object exists in the provision of an accumulator cavity which is readily chargeable with fluid pressure. A still further object relates to the mounting of the striker plate or element on the casing which houses the impacting hammer or mass, in this respect, the connection between the hammer cage and the striker plate including resilient means serving to cushion the relationship between the components and thereby avoiding early destruction of the device. It is a still further object to construct the device of such design that it may readily employ simple components, many of which may be inexpensive castings and others of which are easily machined, it being a feature of the invention to incorporate therein simplicity and economy of design, ease and flexibility in use and involving relatively few service and maintenance problems.

The foregoing and other important objects and desirable features inherent in and encompassed by the invention will become apparent to those versed in the art as preferred embodiments of the invention are disclosed in detail in the ensuing description and accompanying sheets of drawings, the figures of which are described below.

FIGURE 1 is a plan of one form of the apparatus, with a portion broken away and with allied components illustrated schematically.

FIGURE 2 is a side view, partly in section, as seen along the staggered section line 2—2 of FIGURE 1.

FIGURE 3 is a fragmentary section as seen along the line 3—3 of FIGURE 1.

FIGURE 4 is a view similar to FIGURE 2 but showing the hammer or mass displaced from its FIGURE 2 position.

FIGURE 5 is a view similar to FIGURE 2 but showing a modified form of the invention involving manual control.

FIGURE 6 is a partial plan view of a further modified form of the invention involving a different form of spacer means between the striker plate and the other components of the structure.

FIGURE 7 is an elevation of the structure shown in FIGURE 6.

FIGURE 8 is a fragmentary section of a further modification showing a different form of outlet passage for discharging the fluid-pressure chamber.

For the purposes of convenience in description and illustration, the apparatus is shown in the drawings as occupying a certain position in which a striker element or base plate **10** occupies a horizontal position. It will be appreciated, of course, that the apparatus may assume other locations, according to the mechanisms etc. with which it is associated. For present purposes, the plate **10** is shown as being provided with a plurality of openings **12** which may receive bolts (not shown) as representative of means by which the device or apparatus may be secured to the object to be vibrated etc. Again, as purely typical of one form of the construction, the plate **10** is shown as being square as seen from above; although, obviously, it may assume any desired shape.

Secured to the plate and rising therefrom is a ring **14** which affords an annular wall or spacing means which is secured to the plate as by a plurality of cap screws **16** threaded into the plate as at **18** via bores **20** and counterbores **22** in the ring. The centers of the bores **20**, **22** lie on a circle concentric with the ring **14**, but here again this is typical only of the particular construction shown, and the details are of course variable. Each counterbore contains resilient means in the form of a coiled compression spring **24**, one end of which is abutted by the head **25** of the cap screw **16** and the other end of which abuts the shoulder formed by the junction between the bore **20** and the counterbore **22**. As will be clear, the tops of the heads **25** of the cap screws **16** are flush with the top or upper surface of the spacer ring **14**. Since the head **25** of each cap screw is slidable in the counterbore **22**, and further since the shank of each cap screw is axially slidable in its bore **20**, it follows that the plate **10** may move away from the bottom of the ring **14** within the limits permitted by the springs **24**, and these springs will of course return the plate **10** to its starting position, which function is important from the standpoint of cushioning the plate against the relatively considerable forces developed in the apparatus by a hammer or weight **26** disposed within the cage or housing formed in part by the plate **10** and spacer means **14**, the latter being preferably interiorly annularly recessed as shown at **28** so that the hammer or weight is relatively loosely confined in the cage.

The hammer in this case is preferably cylindrical in keeping with the particular design illustrated and has a central upright bore **30** slidably guided on an upright pin **32** rigidly secured to the plate **10** and rising from the center thereof. The hammer or mass **26** is provided with a plurality of bores **34** preferably arranged on a circle concentric with the axis of the weight, and each of these contains a coiled compression spring **36** having its lower end seated on the top surface of the striker plate **10**. The bore **30** and pin **32** constitute guide means for controlling vertical movement of the weight **26**, the vertical dimension of which is less than that between the top surface of the plate **10** and the plane of the upper surface of the spacer ring **14**. The springs **36** represent one form of means for biasing the weight **26** away from the striker plate **10** while yielding to permit movement of the weight toward the striker plate. Any other form of biasing means could

be used. Likewise, if the device were inverted from the positions illustrated in the drawings, the weight 26 could of course be biased by its own weight to move away from the plate 10 in what may be regarded as a starting position In the present case, the specific arrangement of the springs 36 has significant advantages, since the number of springs may be varied to vary the characteristics of operation of the apparatus, because variation in the number and types of springs will of course vary the forces opposing movement of the weight 26 into contact with the striker plate 10.

Another portion of the cage for containing the reciprocating hammer 26 is represented by a top plate 38 which is here parallel to the plane of the plate 10, being therefore of course radial to the axis of the weight 26, which is again a pecularity of the particular construction shown. Sandwiched between the undersurface of the plate 38 and the top surface of the ring 14 is a diaphragm 40, the peripheral or marginal portion of which is secured to the structure along with the plate 38 by means of a plurality of fastener means, here in the form of cap screws 42. The central under portion of the plate 38 is upwardly recessed at 44 to increase the clearance between the undersurface of that plate and the top surface of the weight 26, thereby affording an increased space in which the diaphragm can be deflected or displaced between the position of FIGURE 2 and that of FIGURE 4. The diaphragm in this case acts as a piston in place of the upper surface of the weight 26, and relatively complicated sealing problems are avoided by using the diaphragm instead of tightly fitting the weight 26 within the ring 14 to serve as a piston per se.

Thus, the space between the undersurface 44 of the plate 38 and the upper surface of the diaphragm 40 comprises a chamber or cavity 46 which may be charged by and discharged of fluid under pressure. In the situation of FIGURE 2, the chamber 46 is discharged of fluid, since the hammer or mass 26 is in its upper position. The opposite end of the reciprocation stroke of the hammer or mass 26 is shown in FIGURE 4, at which time the chamber 46 is charged or expanded. In other words, when the chamber 46 is charged, the diaphragm is displaced downwardly, causing the hammer to likewise move downwardly and to strike the plate 10, imparting a force of considerable magnitude to the plate. When the chamber 46 is discharged, the weight 26, being biased away from the plate 10, rebounds. Variations in the frequency of reciprocation of the weight or mass 26 may be accomplished by regulating the charging and discharging of the chamber 46.

It is found in actual practice that charging and discharging of the chamber is best accomplished by the introduction to and exhaust therefrom of an elastic fluid, such as air, especially in conjunction with an accumulator, which is here accomplished by rigid conection to the hammer cage 10–14–38 of what may be regarded as a dome 48, the peripheral flange of which is rigidly secured to the cage by the cap screws 42. At this point, it should be noted that the cap screws pass only through the flange of the dome 48, the plate 38, the diaphragm 40 and into the ring 14. In other words, these components are secured together independently of the fastening means, previously described at 16–25, for connecting the plate 10 to the cage. Consequently, cushioned movement of the plate 10 away from the cage does not affect the seal between the ring 14, diaphragm 40, plate 38 and dome 48.

The dome 48 is of such shape and character that the interior thereof affords an accumulator or cavity 50 having means for the connection thereof to a source of fluid pressure. In the present case, a portion of the wall of the accumulator is provided with a tapped opening 52 which is connectible in any suitable manner to a fluid pressure source, such as an air compressor shown here schematically at 54, the pressure line of which is shown schematically at 56 as including a regulating valve 58. The junction between the cavity 50 and the top of partition plate 38 may be appropriately sealed in any manner, the seal shown here at 60 being merely representative.

The accumulator 50 is placed intermittently in communication with the chamber 46 by means to be presently described. In the present case, the plate 38 is provided with a central passage or opening 62 under control of means including a plunger 64 having at its lower end a valve portion 66 which is operative to open and close the opening 62 according to the position of the plunger. For the purpose of guiding vertical movement of the valve plunger 64, the dome 48 is provided interiorly with a coaxial preferably integral sleeve 68 in which the valve plunger 64 is slidably carried. Biasing means in the form of a coiled compression spring 70 acts between the shoulder afforded on the sleeve and the valve head 66 to bias the valve to a closed position with respect to the plate opening 62, the spring of course yielding, as will be brought out below, to enable the valve to open. The valve plunger is here in the form of a tube and its interior is therefore hollow to afford a relatively restricted outlet passage 72, the upper end of which is open to atmosphere via a pair of diametrically opposed transverse slots 74 in an upper collar 76 which is removably secured to the top of the central portion of the dome by a pair of cap screws 78. These cap screws however are passed first through a top cover plate 80 which overlies but does not obstruct the radial or diametrical passages 74. This will be clear from the portion broken away in FIGURE 1, as well as from the sections in FIGURES 2 and 4.

Since the passage or bore 72 through the valve plunger 64 opens at its top end to atmosphere via 74—74 and since it opens at its bottom end to the chamber 46 (FIGURE 4), it will be seen that this passage comprises an outlet for the chamber 46. As a further part of the valve construction, the lower end of the plunger 64 has a coaxial extension or projection 82 which, in this modification of the invention, is adapted to be engaged by the proximate portion of the diaphragm 40. Since the diaphragm is in engagement with the hammer 26 and to that extent may be regarded in effect as part of the hammer, the relationship between the valve extension 82 and the diaphragm and weight is such that opening of the valve is responsive to rebound of the hammer 26 from the plate 10.

Experience has shown that on occasion air will be trapped in the space between the diaphragm 40 and the side and under portions of the weight 26, which may at times interfere with starting of the reciprocation of the hammer; although, the enlargement at 28 would be expected to accommodate this situation. Nevertheless, it is deemed expedient to provide the spacer ring 14 with a vent 84 which may be fitted with a controllable outlet such as provided by a petcock 86 (FIGURE 1). These details may of course be varied.

The operation of this form of the invention will be described immediately below.

The source of pressure 54–56–58 may be regarded as a constant source which of course continuously charges the accumulator or accumulator cavity 50 in the dome 48, the combination being effected at 56–52. The regulating valve 58 is controllable to regulate the pressure. If it be assumed that FIGURE 2 represents what may be regarded as a starting position, it will be seen that communication between the accumulator 50 and air chamber 46 is established, because the valve plunger is in its up position and the valve opening or passage 62 between the accumulator 50 and the chamber 46 is open, the hammer 26 being in its up or rebounded position because of the biasing means, here comprising the springs 36. Therefore, the air pressure is supplied through the opening 62 to the chamber 46, expanding the chamber, of course, and moving the hammer 26 downwardly so that it strikes the plate 10. Immediately, the spring 70 behind the valve plunger 64 moves the valve to its closed position, thereby discontinuing communication between the accumulator and the air pressure chamber 46. But

the valve head 66, contacting the top of the plate 38 about the valve opening 62, stops downward travel of the plunger and, as shown in FIGURE 4, the upper surface of the diaphragm 40, following the weight 26, clears the lower end of the valve extension 82. The air chamber 46 is now in direct communication with the bore or passage 72 through the valve plunger 64 and since the upper end of this passage is in communication with the atmosphere at 74—74, the chamber 46 will be discharged. It will be observed that the bore or passage 72 is relatively restricted as compared with the area of the valve opening 62.

As the hammer 26 rebounds from the plate 10 it of course displaces the diaphragm 40 back into the recessed portion 44 of the chamber 46 and the diaphragm not only closes the lower end of the passage 72 but also moves the valve 64 back to its open position against the bias of the spring 70.

The situation is again as represented in FIGURE 2; that is, the passage 72 through the valve plunger 64 is closed but the communication between the accumulator 50 and air chamber 46 is again established via the opening 62. Since the accumulator is continuously charged, the pressure again acts on the diaphragm 40 to displace the hammer 26 downwardly on another reciprocation stroke, following which rebound occurs and the cycle is repeated continuously as long as the chamber or accumulator 50 is pressurized or charged. It will be clear of course that impacts occur as the hammer 26 moves toward and/or strikes the plate 10 (depending upon air pressure) and rebounds therefrom toward the plate 38. In the case of both impacts, the relationship between the components above the plate 10 and the plate 10 itself is such that the shocks are cushioned. The entire casing, which represents the apparatus as described, may be, as previously described, attached to an object or other mechanism to which these vibratory forces are desired to be imparted. The construction is extremely simple and the design is such that undue complications of sealing, maintenance of tolerances etc. are avoided. The mechanism is fully automatic because of the responsive relationship between the valve 64 and the hammer 26.

The illustrated design is but a specific embodiment of other forms that it could assume. As already mentioned, the plate 10 need not be square, nor need the weight 26 be cylindrical. Also, as already mentioned, if the apparatus were inverted, gravity could be relied upon as means for biasing the weight 26 away from the plate 10. Also, the spring 70 behind the valve plunger 64 could be omitted. However, these characteristics have been successfully employed in operation and therefore have demonstrated their utility. In view of what has appeared to be a relatively novel concept, other variations could well be indulged in.

The modified form of the apparatus as shown in FIGURE 5 embodies substantially all of the principles already described, and to the extent that the two devices have parts in common, identical reference characters will be employed; however, limited only to essential parts such as the striker plate 10, the spacer ring 14, the diaphragm 40, the partition plate 38, accumulator dome 48 and accumulator cavity 50 and spring loaded valve 64, with the exception that since this valve is somewhat different from the valve 64 in that it omits the extension 82, the valve in FIGURE 5 will be identified at 64'. The plate 38 has the valve opening 62 and the pressure line connection 52. The spacer ring 14 has, preferably, a permanently open vent 84' to prevent entrapment of air below the hammer and diaphragm.

It is a further characteristic of the FIGURE 5 construction that the valve 64' is capable of being manually rather than automatically operated. To this extent, the dome 48 is provided with a manually operated element in the form of a pivoted lever 90 having a forked or bifurcated end extending toward and engaging beneath a head 92 on the valve plunger 64'. Depression of the outer end of the lever or handle 90 will raise the valve plunger 64' against its biasing spring, it being clear that the spring normally holds the plunger 64' down in a position to close the opening 62 and thus to disconnect communication between the accumulator cavity 50 and the air pressure chamber 46.

In the operation of this form of the apparatus, air pressure is supplied continuously to the accumulator 50 and, with the valve plunger 64' in its closed position, no pressure is transmitted to the chamber 46 and consequently the weight 26 is in its rebounded or upper position. When the handle 90 is tripped, the valve plunger 64 is raised, and the accumulated pressure in the accumulator 50 enters the chamber 46 via the opening 62, forcing the weight 26 of course downwardly to impact against the striker plate 10, followed by rebound thereof under action of its biasing springs 36. Release of the handle 90 immediately is followed by closing of the opening 62 by the descending biased plunger 64', but the air chamber 46 is of course discharged because the tubular passage 72' through the plunger 64' opens to atmosphere at its upper end at 74'. Since the valve plunger 64' is not opened automatically in response to rebound of the hammer 26, as in the case of FIGURES 1 through 4, the apparatus of FIGURE 5 is capable of being controlled for individual impacts, which becomes significant in the handling of certain types of hopper-contained material, wherein it is found that a session of rapid vibrations may cause the material to settle rather than to become unloaded. In those cases, one or two blows or impacts will be found to be more beneficial than a series of relatively rapid vibrations. In other words, the number of impacts developed in the apparatus of FIGURE 5 depends upon the number of times that the handle or lever 90 is tripped.

FIGURES 6 and 7 show a further modification of the invention, which may embody the apparatus of FIGURES 1 through 4 or that of FIGURE 5, since the distinction lies primarily in the construction of the spacer means. In the apparatuses described above, the spacer means 14 is represented by an annular or solid ring 14. In the instances of FIGURES 6 and 7, the spacer means comprises a plurality of individual spacers in the form of sleeves 14' arranged in a circle surrounding the weight 26 above the plate 10. The cap screws 42 are replaced with longer cap screws 42' which extend completely respectively through the sleeves or spacers 14' and are threaded into the plate 10. This is illustrated in the broken-away portion in FIGURE 7. Other than that, the construction may embody either form of the invention as already described.

FIGURE 8 is a fragmentary section of a further modification which may be embodied in the construction of FIGURES 1 through 4 or in the construction of FIGURE 5, as modified or not by the construction of FIGURES 6 and 7. The distinction here is that the plate 38 is replaced by a plate 38' which, in addition to having a central opening 62' corresponding to that already described at 62, has a vent passage 72'' which communicates directly with the air pressure chamber 46. The vent or outlet passage 72'' is substituted for the hollow passage through the plunger, the valve plunger in this case, identified at 64'', being preferably solid. In the instance shown, the plunger 64'' is like the plunger 64, to the extent that it has an extension 82' thereon which gives the automatic operation as in FIGURES 1 through 4. It will be clear that the construction of FIGURE 8 could be just as well embodied in the construction of FIGURE 5, omitting, of course the valve plunger extension 82'.

It also follows that operation of an apparatus substituting the outlet passage 72'' of FIGURE 8 for those at 72 or 72' will parallel the operations already described and further reference need not be indulged.

In any form of the invention, the striker plate may be omitted and the remainder of the cage attached directly to the hopper or other object to be vibrated, as by threading the cap screws 42 directly into such hopper etc., or

otherwise, and in some cases it may be desired to omit the cushioned fastener means 16–24. It should be noted that where the spools or spacers 14' are used, they can also function as guides for the hammer and the center guide pin, as at 32 in FIGURES 1–4, could be omitted. In that case, a single spring, if desired, could be used in a central bore, such as in the bore at 30 in FIGURES 1–4.

The above are but a few of the several variations and ramifications that the invention may assume in the exploitation thereof, and these in turn will be increased as uses and environments for the invention are developed. All of these will readily occur to those versed in the art, all without departure from the spirit and scope of the invention.

What is claimed is:

1. A vibrator, comprising: support means adapted to be associated with an object to be vibrated and including first and second axially spaced walls and spacer structure intermediate and secured to said walls to define a hammer cage, said first wall having a central opening therein; a reciprocatable hammer carried within the cage for movement alternately in opposite directions to strike and rebound from the second wall and biased toward the first wall, said hammer having first and second axially opposite sides respectively facing said first and second walls and said second side being adapted to strike said second wall and said first side including pistons means combining with said first wall to provide a fluid-chargeable and -dischargeable chamber with which the aforesaid first wall opening communicates; means coaxially connected to the support means at the side of the first wall opposite to the chamber and combining with the first wall to provide a fluid-chargeable and -dischargeable accumulator, said means including a third wall axially spaced from the first wall; sleeve means on said third wall within the accumulator and extending coaxially toward but short of said first wall opening; a valve plunger carried by the sleeve for movement axially toward and away from said first wall respectively in closing and opening directions as respects said first wall opening, said plunger including a stem having an axially slidable, substantially fluid-tight fit within the sleeve and further having an enlarged head adapted to seat on and be unseated from said first wall opening, the portion of the stem within the sleeve being open to atmosphere; means biasing the plunger in its closing direction; valve-operating means for moving the plunger in its opening direction; and means for discharging the aforesaid chamber after said head seats on said first wall opening so as to enable the hammer to rebound and to again unseat said valve head.

2. The invention defined in claim 1, in which: the plunger has a coaxial portion extending beyond the head and into the first wall opening for contact by the piston means as the hammer rebounds to provide said valve-operating means; and the means for discharging the chamber includes a passage through the plunger opening at one end to atmosphere and opening at its other end at said coaxial plunger portion, said other end being closable by the piston means in contact therewith and openable by departure of the piston means therefrom as the hammer moves to strike the second wall of the support means.

3. The invention defined in claim 1, in which said valve-opening means includes an external member movably mounted on the support means and directly connected to the plunger for moving said plunger in its opening direction.

4. A vibrator, comprising: support means adapted to be associated with an object to be vibrated and including first and second axially spaced walls and spacer structure intermediate and secured to said walls to define a hammer cage, said first wall having a central opening therein; a reciprocatable hammer carried within the cage for movement alternately in opposite directions to strike and rebound from the second wall, means biasing the hammer

toward the first wall, including a plurality of selectively removable springs arranged in a group about the axis of said structure and interposed between said second wall and said second side of the hammer; means coaxially connected to the support means at the side of the first wall opposite to the chamber and combining with the first wall to provide a fluid-chargeable and -dischargeable accumulator, said means including a third wall axially spaced from the first wall; sleeve means on said third wall within the accumulator and extending coaxially toward but short of said first wall opening; a valve plunger carried by the sleeve for movement axially toward and away from said first wall respectively in closing and opening directions as respects said first wall opening; valve-operating means for moving the plunger in its opening direction; and means for discharging the aforesaid chamber after said head seats on said first wall opening so as to enable the hammer to rebound and to again unseat said valve head.

5. The invention defined in claim 4, including; coaxial hammer guide means between the hammer and said second wall and centered among said group of springs.

6. A vibrator, comprising: spaced apart top and bottom plates; spacer structure interposed between said plates and having marginal underportions seating on said bottom plate and an upper peripheral portion disposed closely below a peripheral underportion of said top plate; a diaphragm interposed between the top plate and the spacer structure and having a peripheral portion sandwiched between said upper peripheral portion of said structure and said peripheral underportion of the top plate, said diaphragm providing a hammer cage between itself and the bottom plate and a fluid-chargeable and -dischargeable chamber between itself, and the top plate; means above the top plate providing a fluid-chargeable and -dischargeable cavity and having a marginal portion abutting the top peripheral portion of the diaphragm; fastening means passed through said marginal portion, through the top plate peripheral portion and through the diaphragm peripheral portion and into the spacer structure for securing said cavity means, said top plate, said diaphragm and said spacer structure rigidly together in fluid-tight relation; means securing the bottom plate to the spacer structure; a hammer in the hammer cage and having a top side contacted by the diaphragm and a bottom side adapted to strike and rebound from the bottom plate; means biasing the hammer away from the bottom plate; and means for controlling fluid communication between the accumulator and said chamber, including an opening in the top plate and a valve carried by the accumulator means for movement between closing and opening positions as respects said opening.

7. The invention defined in claim 6, in which: the chamber is dischargeable to atmosphere via a passage through the valve.

8. The invention defined in claim 6, in which: the chamber is dischargeable to atmosphere via a passage through the top plate.

9. The invention defined in claim 6, in which: said means securing the bottom plate to the spacer structure is separate from said fastening means and includes cushioning means yieldingly securing said bottom plate to said spacer structure.

References Cited by the Examiner

UNITED STATES PATENTS

637,810	11/99	Meissner	121—25
966,691	8/10	Killing	121—14
1,045,956	12/12	Demmler	121—14
1,057,594	4/13	Taylor	121—14
1,144,758	6/15	Desmond	121—14
1,643,427	9/27	Swan et al.	121—14
1,653,675	12/27	Stoney	22—45

(Other references on following page)

9

UNITED STATES PATENTS

2,119,285	5/38	Morgan	121—17
2,120,992	7/38	Seiden	91—224
2,303,666	12/42	Souter	91—5
2,472,568	6/49	Burt	91—50
2,574,574	11/51	Ives	92—94
2,854,953	11/58	Osborne	173—2
2,872,901	2/59	Goldring	91—417

10

2,971,386	2/61	Lippke	74—55
3,010,430	11/61	Allen et al.	173—119

FOREIGN PATENTS

145,126	6/20	Great Britain.

BROUGHTON G. DURHAM, *Primary Examiner.*

KARL J. ALBRECHT, *Examiner.*