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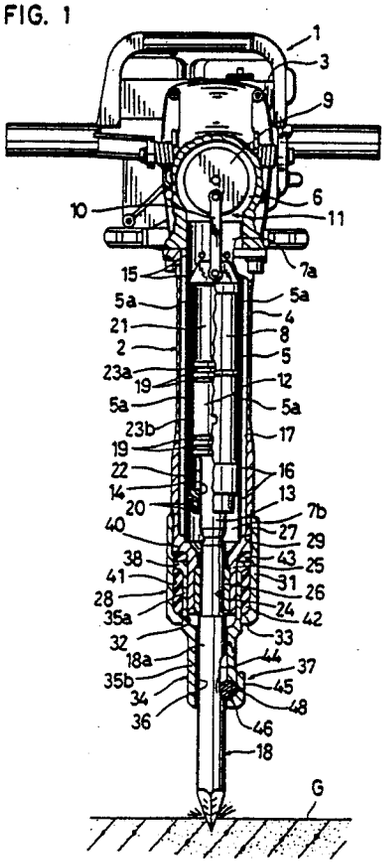
(54) Percussion apparatus with tool holder.

(57) A percussion apparatus comprises a vertically extending tubular housing (2), an end cap (28) removably mounted to the lower end of the housing, and a tool holder (34) extending through the end cap as elastically supported thereby and slidably movable axially of the housing. A chisel (18) extends through the holder and has a head located within the housing to be hit by a hammer rod (13) axially reciprocated in the housing. A tool holding device (37) is mounted on the holder outside the end cap for selecting a first condition in which the chisel is prevented from falling off the holder while being allowed to move axially within a limited range, and a second condition in which the chisel is allowed to be completely removed from the holder.

FIG. 1



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PERCUSSION APPARATUS

This invention relates to a percussion apparatus which is used for example at construction sites to break solid bodies such as concrete bodies and hardened asphalt bodies.

In general, a percussion apparatus or concrete breaker comprises a vertically extending tubular housing having an integral tool holding portion at the lower end thereof, a working tool or chisel supported at the housing tool holding portion and movable axially of the housing within a limited range, and a hammer pneumatically or mechanically reciprocated axially within the housing to repetitively hit the head. In operation, the chisel is pressed against a workpiece, and repetitively hit by the hammer until the workpiece is cracked.

Before crack formation, the impact force applied to the chisel balances with the reaction force from the workpiece, so that the chisel assumes a balanced axial position relative to the tool holding portion of the housing. When the workpiece is cracked, on the other hand, the reaction force from the workpiece abruptly disappears to allow the chisel to advance to its lower limit of movement although the chisel is prevented from falling off the tool holding portion by a stopper provided either on the chisel or on the tool holding portion. If the chisel is idly hit by the hammer in this condition, all impact energy is transmitted to the tool holding portion which is integral with the housing. A similar situation also occurs when the reciprocation of the hammer is started before the chisel is pressed against the workpiece. Therefore, the housing and the tool holding portion must have a large wall thickness to endure such impact energy, resulting in an increase in the overall weight of the apparatus.

In view of the above problem, U.S. Patent No. 4,103,747 to Finney discloses a percussion apparatus in which idle hitting by a hammer of a chisel is avoided when the chisel is not pressed against a workpiece. More specifically, the percussion apparatus of this patent comprises a tool guide mounted on the lower end of a vertically extending tubular housing, and the chisel is slidably fitted in the tool guide so as to be movable vertically between an upper position in which the head of the chisel projects above the top surface of the tool guide and a lower position in which the chisel head is located below the tool guide top surface. When the chisel is pressed against the workpiece, the chisel head is raised above the tool guide top surface to be hit by the hammer for intended workpiece breaking. Upon crack formation in the workpiece for example, the chisel head is lowered below the tool guide top surface by the weight of the chisel, so that the hammer will no longer hit the chisel head.

The percussion apparatus of the above U.S. patent, while capable of avoiding idle impacting, gives rise to a new problem, as described below.

In case the workpiece is of sticky nature, a final impact imparted by the hammer immediately before crack formation drives the chisel deep into the workpiece upon crack formation. Despite such crack formation, the workpiece is not actually divided into pieces due to its stickiness, so that the chisel will be caught firmly by the incompletely cracked workpiece.

Once this happens, the operator must manually pull out the chisel with a force required for supporting the overall weight of the percussion apparatus plus for disengaging the arrested chisel from the workpiece. This force is considerably large because the overall weight of the apparatus is relatively large.

It is obviously preferable that the chisel be oscillated at its lower limit position in order to facilitate taking the arrested chisel out of the sticky workpiece. However, if the chisel in its lower limit position is made to be hit by the hammer for oscillation, a large impact is transmitted to the tool guide or holder, so that the tool guide must be strong enough to endure the impact. Therefore, such an arrangement leads to a weight increase of the apparatus and fails to give a solution to the problem.

Japanese Laid-open Patent Application No. 61-100380 of the same applicant proposes another percussion apparatus which comprises a vertically extending housing in which a hammer is vertically reciprocated, a tubular end cap removably mounted to the lower end of the housing and having a bottom wall formed with a central hole, and a slider (tool holder) slidably fitted in the central hole of the end cap and having an axial bore coaxial with the housing. The slider further has an outward annular flange in slidable contact with the tubular wall of the end cap. An annular elastic member is interposed between the slider flange and the cap bottom wall. A chisel extends through the axial bore into the housing to be hit by the reciprocating hammer. The chisel is formed at an intermediate portion with an annular stopper flange located above the annular flange of the slider. A compression spring is disposed within the end cap between the chisel flange and the lower end of the housing to press the chisel flange downward into abutment with the slider flange.

The hammer is capable of hitting the chisel head even when the chisel assumes its lower limit

position in which the chisel flange is held in abutment with the slider. The chisel thus hit causes compression and subsequent restoration of the elastic member by way of the chisel flange and the slider. As a result, the chisel oscillates to facilitate removal thereof from a sticky workpiece while the impact is buffered by the elastic member.

However, since the chisel flange is larger in diameter than the axial bore of the slider, the chisel cannot be removed from the end cap without removing the end cap from the lower end of the housing, consequently requiring a considerable time for replacement of the chisel. Further, the mounting of the chisel must be conducted by inserting it into the axial bore of the slider from above the end cap which has been removed from the housing. Thus, it is not possible to mount a chisel having a chisel tip whose size is larger than the shank diameter of the chisel.

It is, therefore, an object of the invention to provide a percussion apparatus which, while retaining the advantages of the above laid-open Japanese application, facilitates replacement of working tools (or chisels) and enables the use of various working tools whose tip size may be larger than the shank diameter of the tool.

According to the invention, there is provided a percussion apparatus comprising: a tubular housing providing a generally vertical axis; a working tool having a shank which is supported at the lower end of the housing so as to be movable axially thereof within a limited range, the working tool further having a head located within the housing; hammer means driven to reciprocate axially within the housing to repetitively hit the head of the working tool when the tool assumes any axial position within said limited range; an end cap having a tubular wall removably mounted to the lower end of the housing, the end cap further having a bottom wall formed with a hole coaxial with the housing; a tool holder slidably fitted in the hole of the cap bottom wall and formed with an axial bore coaxial with the housing for receiving the shank of the tool, the holder having an outward annular flange disposed within the end cap; a lower elastic member disposed below the annular flange of the holder to be compressed thereby when the holder is slidably moved downward relative to the end cap; and an upper elastic member disposed above the annular flange of the holder, characterized in that the upper elastic member directly contacts the annular flange of the holder to be compressed thereby when the holder is slidably moved upward relative to the end cap, the holder has a lower portion arranged outside the end cap, a tool holding device is mounted on said lower portion of the holder for selecting a first condition in which the tool is prevented from falling off the holder while being allowed to move axially of the housing within said limited range, and a second condition in which the tool is allowed to be completely removed from the holder.

According to a preferred embodiment of the invention, the shank of the tool is formed with a cutout bounded by an upper stopper surface and a lower stopper surface; and the tool holding device comprises a lateral mounting bore formed in said lower portion of the holder and extending perpendicularly to the axial bore of the holder in partially overlapping relation, and a stopper pin inserted into the lateral mounting bore to partially protrude into the cutout of the tool shank, the stopper pin being engageable with the upper and lower stopper surfaces.

Advantageously, the stopper pin is formed with a recess which becomes flush with the axial bore when the pin is rotated. In this way, the selection between the first and second conditions can be made simply by rotating the stopper pin. The stopper pin is provided at one end with a lever for facilitating rotation thereof.

The invention will now be described further, by way of example only, with reference to accompanying drawings, in which:

Figure 1 is a view in longitudinal section showing a percussion apparatus according to the invention at the time of just starting an impacting operation;

Figure 2 is a slightly enlarged view in longitudinal section showing a principal portion of the same apparatus;

Figure 3 is a sectional view taken along lines III-III in Figure 2;

Figure 4 is a sectional view taken along lines IV-IV in Figure 2;

Figure 5 is a view similar to Figure 2 but showing the same apparatus at the time of tool take-out operation;

Figure 6 is a view in longitudinal section showing a principal portion of another percussion apparatus according to the invention;

Figure 7 is a section taken along lines VII-VII in Figure 6; and

Figure 8 is a view similar to Figure 2 but showing the apparatus whose working tool is replaced by another working tool.

Referring to Figure 1 of the accompanying drawings, a percussion apparatus generally designated by reference numeral 1 includes a vertically extending cylindrical housing 2, and an engine 3 mounted on the top of the cylindrical housing 2. The engine 3 may be a known two-cycle gasoline engine available in the market. Of course, the engine may be replaced by an electric or pneumatic motor although the latter requires electric wiring or pneumatic tubing to pose a limitation on portability of the percussion apparatus.

The housing 2 has a cylindrical main portion 4 within which a stationary cylinder 5 is disposed. An upper portion of the cylinder 5 internally defines an upper cylinder chamber 7a communicating with a crank room 6 thereabove, whereas a lower portion of the cylinder internally defines a lower cylinder chamber 7b.

Disposed within the stationary cylinder 5 is a movable cylinder 8 connected to a known crank mechanism 11 which includes a rotary disk 9 accommodated within the crank room 6, and a connecting rod 10. Thus, the movable cylinder 8 slidably reciprocates within the stationary cylinder 5 axially thereof as the disk 9 rotates. The disk 9 is driven into rotation by the engine 3 via known reduction gears (not shown) at a predetermined rotational speed of about 1,000rpm for example.

The stationary cylinder 5 is formed with upper ventilation ports 15 and lower ventilation ports 16. These ventilation ports communicate with an annular space 17 formed between the housing main portion 4 and the stationary cylinder 5 in a manner such that air flows into and escapes from the upper and lower cylinder chambers 7a, 7b through the ports as the movable cylinder 8 is reciprocated. In this way, air compression and negative pressure generation within the upper and lower cylinder chambers 7a, 7b can be limited to enable high speed reciprocation of the movable cylinder 8.

A free piston 12 is slidably mounted in the movable cylinder 8 for reciprocation axially thereof. The piston is integrally formed at its lower end with a reduced extension serving as a hammer rod 13 which extends downward through an opening 14 formed in the bottom wall of the movable cylinder 8. The hammer rod 13 is adapted to powerfully hit a working tool or chisel 18 when the piston 12 is moved downward, as will be hereinafter described in detail.

O-rings 19 are mounted on the outer circumferential surface of the free piston 12 to provide air tightness between the free piston 12 and the movable cylinder 8. Further, air tightness between the opening 14 and the hammer rod 13 is provided by O-rings 20 fitted on the circumferential surface of the opening 14. Thus, the internal space of the movable cylinder 8 is divided by the piston 12 into hermetically sealed upper and lower pressure chambers 21, 22 respectively above and below the piston.

When the movable cylinder 8 is reciprocated, the upper and lower chambers 21, 22 are alternately compressed due to inertial delay in movement of the piston 12. Air compression within the upper pressure chamber 21 causes the piston 12 to move downward for hitting the chisel 18. On the other hand, subsequent air compression within the lower pressure chamber 22 makes the piston move upward.

In the embodiment illustrated in Figure 1, the cylindrical wall of the movable cylinder 8 is formed with upper pressure control ports 23a which allow entry of air into the upper pressure chamber 21 to prevent negative pressure generation therein when the piston 12 descends past these ports, thereby avoiding hinderance to downward movement of the piston. Further, the cylindrical wall of the movable cylinder 8 is formed with lower pressure control ports 23b which allow entry of air into the lower pressure chamber 22 to prevent negative pressure generation therein when the piston ascends past the ports 23b, thereby avoiding hinderance to upward movement of the piston. For this purpose, the pressure control ports 23a, 23b communicate with the annular space 17 through intermediate ventilation ports 5a formed in the stationary cylinder 5.

The cylindrical housing 2 is integrally formed at its lower end with a reduced boss portion 25 in which is slidably inserted the shank 18a of the chisel 18, as better illustrated in Figures 2 and 3. More specifically, a bush 26 having a through-bore 24 coaxial with the housing 2 is fitted in the boss portion 25, and the chisel shank 18a is slidably received in the bush 26.

An end cap 28 is removably fitted on the lower end of the housing main portion 4. More specifically, the end cap 28 has a cylindrical wall 31 formed at the upper end thereof with internal threads 29 for screwing engagement with external threads 27 formed on the lower end of the housing main portion 4. The end cap 28 also has a bottom wall 33 formed with a central hole 32 coaxial with the housing 2. The central hole 32 is larger in diameter than the boss portion 25 of the housing 2.

According to the illustrated embodiment, the housing boss portion 25 is hexagonal in outer cross section (see Figure 3) and extends downward to a position substantially corresponding to the bottom wall 33 of the end cap 28.

Extending through the central hole 32 of the end cap 28 is a tool holder 34 which has an upper cylindrical portion 35a slidably fitted on the boss portion 25 of the housing 2, and a reduced lower portion 35b formed with an axial bore 36 coaxial with the housing 2 for receiving the shank 18a of the chisel 18. The upper portion 35a of the tool holder 34 is hexagonal in inner cross section for closely fitting on the housing boss portion 25, but circular in outer cross section for closely fitting in the central hole 32 of the end cap 28, as illustrated in Figures 2 and 3.

The upper portion 35a of the tool holder is formed with an outward annular flange 38 slidably contacting the inner circumferential surface of the cap cylindrical wall 31. Thus, the annular space formed between the cap cylindrical wall 31 and the

housing boss portion 25 is divided by the outward flange 38 into an upper annular chamber 40 and a lower annular chamber 41. These annular chambers 40, 41 are respectively occupied by annular elastic members 42, 43 made of fluorine-containing rubber for example.

The reduced lower portion 35b of the tool holder 34 is located outside the end cap 28 and formed at its lower extremity with an enlarged mounting portion 45 which is arranged eccentrically relative to the axial bore 36 for mounting a tool holding device 37. This tool holding device 37 functions to selectively provide a holding mode in which the chisel 18 is prevented from falling off the holder 34 while being allowed to move axially within a limited range, and a releasing mode in which the chisel is allowed to be removed completely from the holder.

For this purpose, the shank 18a of the chisel 18 is formed with a cutout 44 which is bounded by an upper stopper surface 44a and a lower stopper surface 44b. The cutout 44 has a specified vertical length to allow axial displacement of the chisel 18.

As illustrated in Figures 2 and 4, the tool holding device 37 includes a stopper pin 46 inserted into a lateral mounting bore 30 which is formed in the eccentric mounting portion 45 of the tool holder 34 in partially overlapping relation to the axial bore 36 perpendicularly thereto. The stopper pin 46 is formed with an arcuate recess 48 which is complementary to the cutout 44 of the chisel shank 18a. In other words, the arcuate recess 48 becomes flush with the circumferential surface of the axial bore 36 when the stopper pin 46 is suitably rotated.

Normally, the stopper pin 46 partially projects into the axial bore 36 (see Figures 2 and 4), so that the chisel 18 is prevented from falling off the tool holder 34 by the stopper pin coming into contact with the upper stopper surface 44a while being allowed to move axially within a limited stroke defined by the two stopper surfaces 44a, 44b. On the other hand, when the stopper pin 46 is rotated to render the arcuate recess 48 flush with the axial bore 36, the stopper pin 46 no longer interferes with the stopper surfaces 44a, 44b, thereby enabling removal and replacement of the chisel 18.

According to the illustrated embodiment, the stopper pin 46 is provided at one end thereof with a lever 47 to facilitate rotation. Further, the stopper pin 46 is formed with an annular groove 49 at a position adjacent to the lever 47, and the groove 49 in turn is formed with a diametrically opposite pair of locking recesses 52. A ball 51 biased by a spring 50 is engageable into selected one of the locking recesses 52, the spring 50 being accommodated in a bottomed hole 39 extending perpendicularly to the lateral bore 30. Naturally, one of the two locking recesses 52 corresponds to a rotational position of the stopper pin 46 in which it projects into the axial bore 36, whereas the other locking recess corresponds to another rotational position in which the arcuate recess 48 becomes flush with the axial bore 36. Thus, the stopper pin 46 can be properly adjusted in rotational position by a click imparted by the ball 51 and the locking recesses 52.

The stopper pin 46 may be made removable from and insertable into the lateral bore 30 to provide the intended locking and unlocking function for the chisel 18. In this case, the stopper pin needs not be provided with the arcuate recess 48.

The eccentric mounting portion 45 of the tool holder 34 must have a diameter which is slightly smaller than that of the central hole 32 of the end cap 28. Such diameter is necessary to enable mounting of the tool holder 34, as described below.

According to the the embodiment described above, the tool holder 34 is prevented from rotating relative to the housing 2 because the holder upper portion 35a which is hexagonal in inner cross section (Figure 3) is fitted on the housing boss portion 25 which is also hexagonal in outer cross section. Further, the chisel 18 is also prevented from rotating relative to the holder 34, namely relative to the housing 2, because the stopper pin 46 comes into contact with the flat recess surface 44 of the chisel (Figure 4). However, the holder 34 and the housing boss portion 25 may be cylindrical in inner and outer cross sections, respectively, to allow rotation of the chisel 18 relative to the housing 2.

The end cap 28, the tool holder 34 and the chisel 18 are mounted in the following manner.

First, the lower elastic member 42 is placed into the end cap 28. Then, the tool holder 34 is inserted into the end cap 28 from above until the outward annular flange 38 rests on the lower elastic member 42. During such insertion, the eccentric mounting portion 45 can pass through the central hole 32 of the end cap 28 because the mounting portion 45 is slightly smaller in diameter than the central hole 32. Subsequently, the upper elastic member 43 is placed onto the outward flange 38 of the holder 34, and the end cap 28 is screwed to the threaded portion 27 of the housing 2. Finally, the shank 18a of the chisel 18 is inserted from below into the axial bore 36 of the holder 2 and into the bush 26, and the stopper pin 46 is inserted into the lateral bore 30 to prevent the chisel from falling off.

For replacement of the chisel 18 after use, the lever 47 is pivoted so that the arcuate recess 48 becomes flush with the axial bore 36, and the chisel 18 is removed. Subsequently, a new chisel 18' such as illustrated in Figure 8 is inserted into the axial bore 36, and the lever 47 is pivoted to its

initial position. In this way, replacement of chisels can be conducted very quickly without prior removal of the end cap 28 or the tool holder 34.

As shown in Figure 8, the chisel 18' may be provided with a flattened tip portion 18b' which has a width larger than the diameter of the chisel shank 18a'. The mounting of such a chisel is possible without having to remove the end cap 28 because the chisel can be inserted into the tool holder 34 from below.

The percussion apparatus operates in the following manner.

IMPACTING MODE

With the chisel 18 held against a workpiece G such as concrete or asphalt paved road, the engine 3 is started and increased in speed by operating a throttle lever (not shown). The engine is connectable to the rotary disk 9 through a centrifugal clutch (not shown) which functions to transmit the engine output to the disk 9 only when the engine speed increases to a predetermined value. Thus, at such an engine speed, the movable cylinder 8 is caused by the crank mechanism 11 to reciprocated vertically.

During upward excursion of the movable cylinder 8 from the lower dead point, the lower pressure chamber 22 is compressed due to an inertial delay in upward movement of the free piston 12. Such compression of the lower pressure chamber 22 continues until the movable cylinder 8 approaches the upper dead point, and immediately thereafter the piston 12 starts moving rapidly upward relative to the movable cylinder 8 by the elastic expansion of the compressed lower pressure chamber 22. When the movable cylinder 8 has passed the upper dead point to move downward, the upper pressure chamber 21 is then compressed to a maximum extent by the kinetic energy of the upwardly moving piston 12 and the downwardly moving cylinder 8. Immediately after maximum compression of the upper pressure chamber 21, the piston 12 is rapidly accelerated downward by an extremely strong expansive force of the maximally compressed upper pressure chamber 21. The hammer rod 13 of the piston 12 hits the shank head of the chisel 18 when the piston 12 is accelerated to a maximum speed, thereby driving the chisel 18 into the workpiece G. The maximum speed of the downwardly moving piston 12 may reach several tens of meters per second.

Repetitive hitting by the piston 12 of the chisel 18 is accompanied by repetitive reaction forces from the workpiece, causing the housing 2 to be raised slightly from the position shown in Figure 1 or 2. As a result, the chisel 18 assumes a balanced position relative to the housing 2 or the tool holder 34, wherein the stopper pin 46 is located intermediate the two stopper surfaces 44a, 44b. Thus, the impact imparted to the chisel 18 by hammer rod 13 of the piston 12 will not be transmitted to the tool holder 34.

TOOL PULL-OUT MODE

Repeated impacting by the free piston 12 will ultimately results in deep penetration of the chisel 18 into the workpiece G, forming a crack. Once such a crack is formed, the downward impacts imparted to the chisel 18 no longer balance with the upward reaction forces received from the workpiece G, whereby the chisel is abruptly driven forward. No problem occurs if the workpiece is completely divided into pieces by the crack formation. However, in case the workpiece does not break due to its sticky nature for example, the chisel 18 may firmly engage in the formed crack.

To pull out the chisel 18 thus firmly caught in the cracked workpiece G, it has been conventionally necessary to manually pull up the percussion apparatus 1 with a force corresponding to that required for supporting the overall weight of the apparatus 1 plus for disengaging the firmly arrested chisel 18 from the workpiece. According to the invention, it is possible to pull the arrested chisel out of the cracked workpiece only with a force required to support the weight of the apparatus 1 by utilizing the kinetic energy of the free piston 12, as described hereinbelow.

Referring to Figure 5, the chisel 18 is illustrated as firmly engaging in the workpiece G, and the upper stopper surface 44a of the chisel is held in engagement with the stopper pin 46 because of a manual lifting force applied to the housing 2. In this condition, when the hammer rod 13 of the piston 12 hits the chisel 18, the resulting impact force is transmitted to the tool holder 34 by way of the upper stopper surface 44a and the stopper pin 46, thereby slightly depressing the holder relative to the end cap 28 or the housing 2. Because of the engagement at its outward flange 38, the depressed holder axially compresses the lower annular elastic member 42 which thereafter restores elastically to return the holder to its initial position. The chisel 18 moves with the holder due to the engagement between the upper stopper surface 44a and the stopper pin 46. This means that the chisel 18 oscillates axially with strong forces as long as the piston 12 reciprocates. Such oscillation serves to release the chisel out of firm engagement with the workpiece G even if the latter is very sticky. Therefore, it is possible to pull out the chisel from the workpiece only with a manual force re-

quired to support the percussion apparatus.

During the tool take-out operation described above, it is only the tool holder 34 that is moved by the chisel 18. As compared with the percussion apparatus as a whole, the holder 34 is far smaller in weight, providing a small inertial mass. Therefore, the holder can be easily moved when an impact is applied thereto through the chisel, so that the holder will be subjected only to a minimum tensile stress and need not have a large impact strength. If the holder 34 is integral with the housing 2 to provide a large inertial mass, on the other hand, the holder (or the tool holding portion of the housing) will subjected to a large tensile stress upon impact, so that the housing as a whole must be strong enough to result in an unacceptable increase in overall weight of the percussion apparatus. Thus, the advantage of the independently movable holder 34 is extremely significant.

Further, the lower annular chamber 41 of the end cap 28 is substantially a closed space which is variable in length only in the vertical direction and completely occupied by the lower annular elastic member 42. Therefore, the lower elastic member 42 is deformed uniformly as a whole upon axial compression, so that it will not be damaged in a short time due to fatigue through local deformation.

As described above, the percussion apparatus according to the invention provides a facilitated tool take-out operation, ready maintenace and tool replacement, is simple in construction and light in overall weight, in addition to providing effective workpiece breaking.

Figures 6 and 7 show a second embodiment of the invention in which a suspension spring 54 is arranged on the annular outward flange 38 of the tool holder 34 to press it downward when the chisel 18" is pressed against the workpiece G. The spring constant of the spring 54 is selected in view of the overall weight of the percussion apparatus and a force applied by the operator so that the chisel 18" projects into the lower cylinder chamber 7b by a suitable amount when the chisel is pressed against the workpiece.

The suspension spring 54, because of its energy absorption, serves to prevent vibration from being transmitted to the housing 2. Further, the spring 54 buffers upward reaction forces which the tool holder 34 receives from the workpiece G through the chisel 18", so that the outward flange 38 of the holder 34 will not collide vigorously with the housing 2. Thus, the housing 2 and the holder 34 need not have a large impact strength, thereby contributing to weight reduction.

As better illustrated in Figure 7, the shank 18a" of the chisel 18" has an intermediate portion 18c" which is hexagonal in cross section for fitting in the axial bore 36' of the tool holder 34 which is also hexagonal in cross section. In this way, the chisel is more effectively prevented from rotating relative to the holder. Naturally, the stopper pin 46 has a recess 48' which is complementary to the hexagonal intermediate portion 18c" of the chisel.

Of course, the invention is not limited to the illustrated embodiments and may be modified in various ways. For instance, the tool holder 34 may not be provided with an eccentric enlarged mounting portion 45 if the lower portion 35a has an enough wall thickness for mounting of the tool holding device 37. Further, both of the upper and lower elastic members may be in the form of a coil spring.

Claims

1. A percussion apparatus comprising: a tubular housing (2) providing a generally vertical axis; a working tool (18, 18', 18") having a shank (18a, 18a', 18a") which is supported at the lower end of the housing so as to be movable axially thereof within a limited range, the working tool further having a head located within the housing; hammer means (13) driven to reciprocate axially within the housing to repetitively hit the head of the working tool when the tool assumes any axial position within said limited range; an end cap (28) having a tubular wall (31) removably mounted to the lower end of the housing, the end cap further having a bottom wall (33) formed with a hole (32) coaxial with the housing; a tool holder (34) slidably fitted in the hole of the cap bottom wall and formed with an axial bore (36, 36') coaxial with the housing for receiving the shank of the tool, the holder having an outward annular flange (38) disposed within the end cap; a lower elastic member (42) disposed below the annular flange of the holder to be compressed thereby when the holder is slidably moved downward relative to the end cap; and an upper elastic member (43) disposed above the annular flange of the holder, characterized in that the upper elastic member (43) directly contacts the annular flange (38) of the holder (34) to be compressed thereby when the holder is slidably moved upward relative to the end cap (28), the holder has a lower portion (35b) arranged outside the end cap, a tool holding device (37) is mounted on said lower portion of the holder for selecting a first condition in which the tool (18, 18', 18") is prevented from falling off the holder while being allowed to move axially of the housing (2) within said limited range, and a second condition in which the tool is allowed to be completely removed from the holder.

2. The percussion apparatus according to claim 1, wherein the shank (18, 18', 18") of the tool (18, 18', 18") is formed with a cutout (44) bounded by

an upper stopper surface (44a) and a lower stopper surface (44b); and the tool holding device (37) comprises a lateral mounting bore (30) formed in said lower portion of the holder (34) and extending perpendicularly to the axial bore (36, 36') of the holder in partially overlapping relation, and a stopper pin (46) inserted into the lateral mounting bore to partially protrude into the cutout of the tool shank, the stopper pin being engageable with the upper and lower stopper surfaces.

3. The percussion apparatus according to claim 2, wherein the stopper pin (46) is formed with a recess (48, 48') which becomes flush with the axial bore (36, 36") when the pin is rotated.

4. The percussion apparatus according to claim 3, wherein the stopper pin is provided at one end with a lever (47) for facilitating rotation thereof.

5. The percussion apparatus according to claim 3 or 4, wherein the tool holding device further comprises an annular groove (49) formed in the circumferential surface of the stopper pin (46), a pair of locking recesses (52) at predetermined positions of the annular groove, and a spring-biased ball for releasable engagement with a selected one of the locking recesses.

6. The percussion apparatus according to any one of claims 1 to 5, wherein said lower portion (35b) of the holder (34) has an eccentrically enlarged mounting portion (45) for mounting the tool holding device (37), the enlarged mounting portion being capable of freely passing through the hole (32) of the end cap (28).

7. The percussion apparatus according to any one of claims 1 to 6, wherein the axial bore (36) of the holder (34) is cylindrical for receiving a cylindrical intermediate portion of the tool shank (18a, 18a').

8. The percussion apparatus according to any one of claims 1 to 6, wherein the axial bore (36') of the holder (34) is polygonal in cross section for receiving an intermediate portion (18c") of the tool shank (18a") which is correspondingly polygonal in cross section.

9. The percussion apparatus according to any one of claims 1 to 8, wherein the lower end of the housing (2) has a tubular boss portion (25) for slidably receiving therein an upper portion of the tool shank (18a, 18a', 18a"), and the holder (34) has an upper tubular portion (35a) slidably fitted around the boss portion.

10. The percussion apparatus according to claim 9, wherein the boss portion (25) of the housing (2) is polygonal in outer cross section for slidably fitting in said upper portion (35a) of the holder (34) which is correspondingly polygonal in inner cross section.

11. The percussion apparatus according to any one of claims 1 to 10, wherein the lower elastic member (42) is annular and made of rubber.

12. The percussion apparatus according to claim 11, wherein the lower elastic member (42) completely occupies the annular space formed between the holder (34) and the end cap (28) below the outward annular flange (38) of the holder.

13. The percussion apparatus according to any one of claims 1 to 12, wherein the upper elastic member is annular and made of rubber.

14. The percussion apparatus according to claim 13, wherein the upper elastic member completely occupies the annular space formed between the housing (2) and the end cap (28) above the outward annular flange (38) of the holder (34).

15. The percussion apparatus according to any one of claims 1 to 12, wherein the upper elastic member is in the form of a coil spring (54).

16. The percussion apparatus according to any one of claims 1 to 15, wherein the outward annular flange (38) of the holder (34) is in slidable contact with the tubular wall (31) of the end cap (28).

FIG. 1

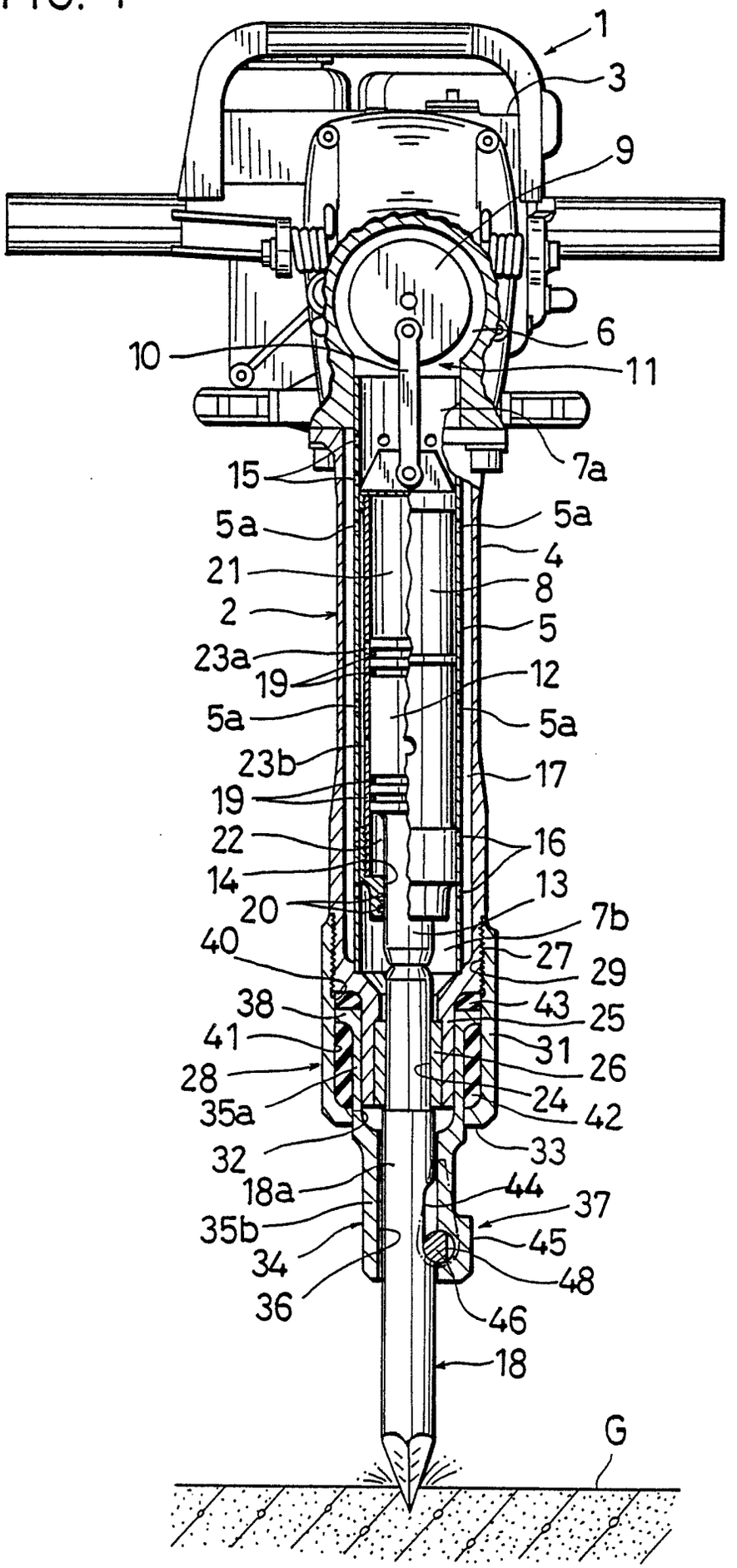
1
3
9
6
10
11
7a
15
5a
5a
4
21
8
2
5
23a
19
12
5a
5a
23b
17
19
22
16
14
13
20
7b
40
27
29
38
43
25
41
31
26
28
24
42
35a
33
32
44
18a
37
35b
45
34
48
36
46
18
G

FIG. 2

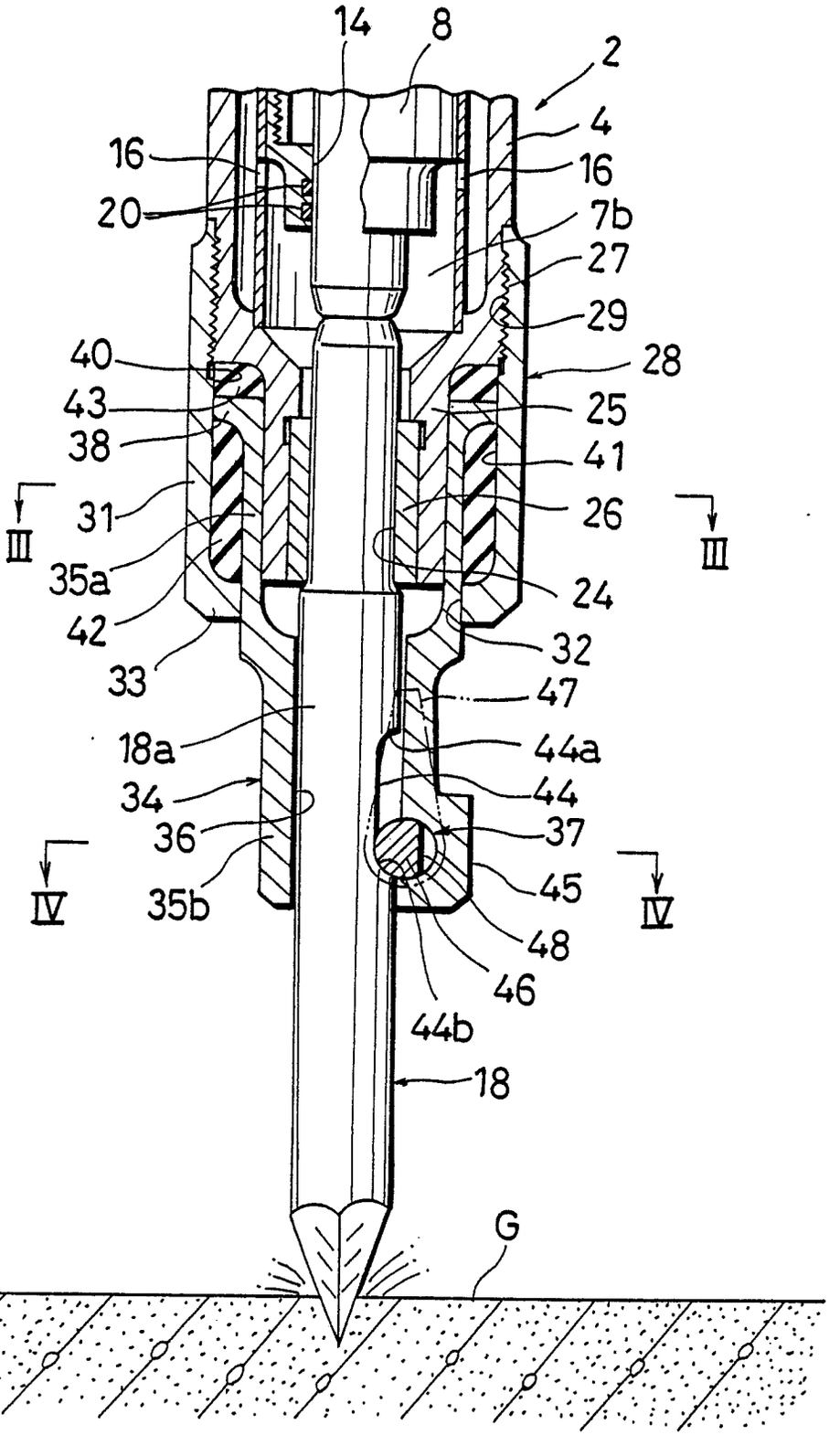
14
8
2
4
16
16
20
7b
27
29
40
28
43
25
38
41
31
26
III
III
35a
24
42
32
33
47
18a
44a
34
44
36
37
IV
35b
45
IV
48
46
44b
18
G

FIG. 3

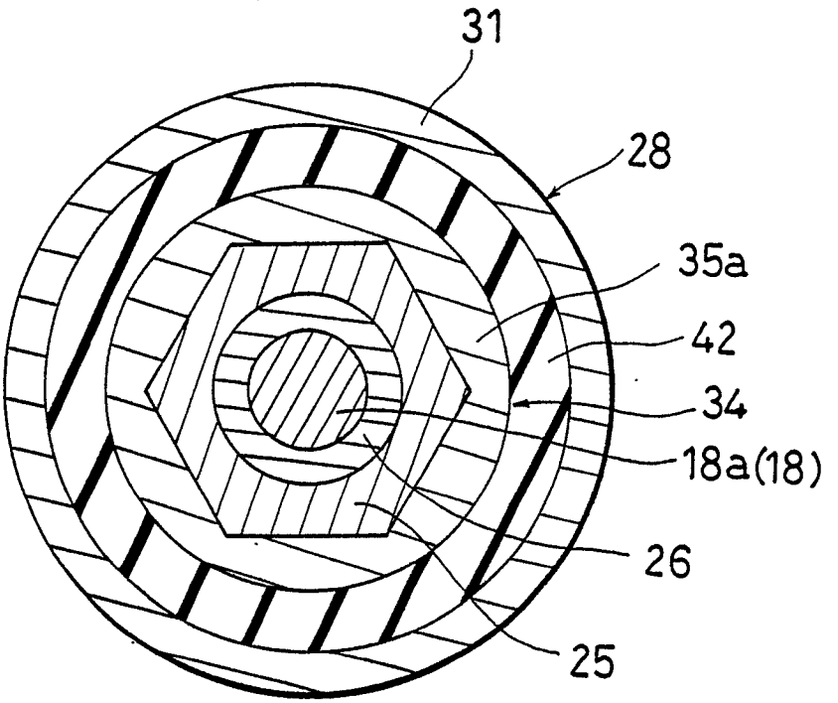
31
28
35a
42
34
18a(18)
26
25

FIG. 4

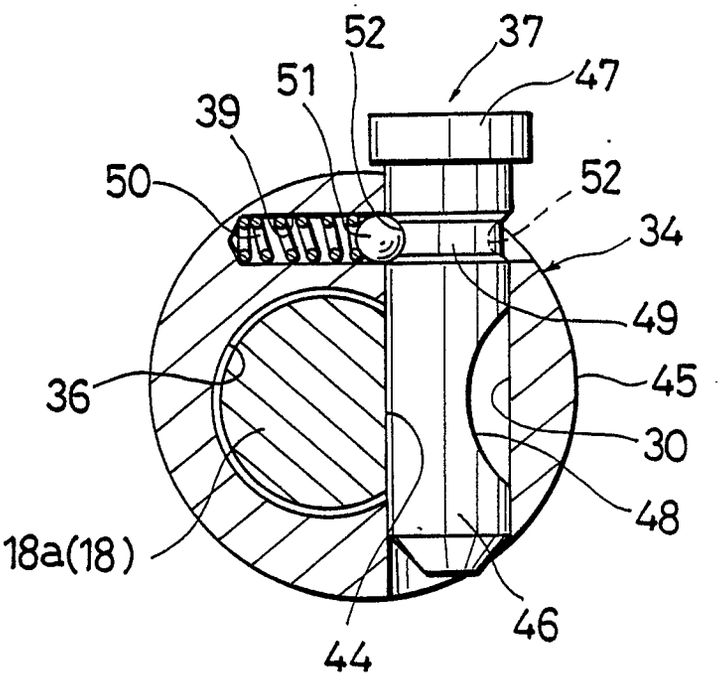
52
37
51
47
39
50
52
34
49
36
45
30
48
18a(18)
46
44

FIG. 5

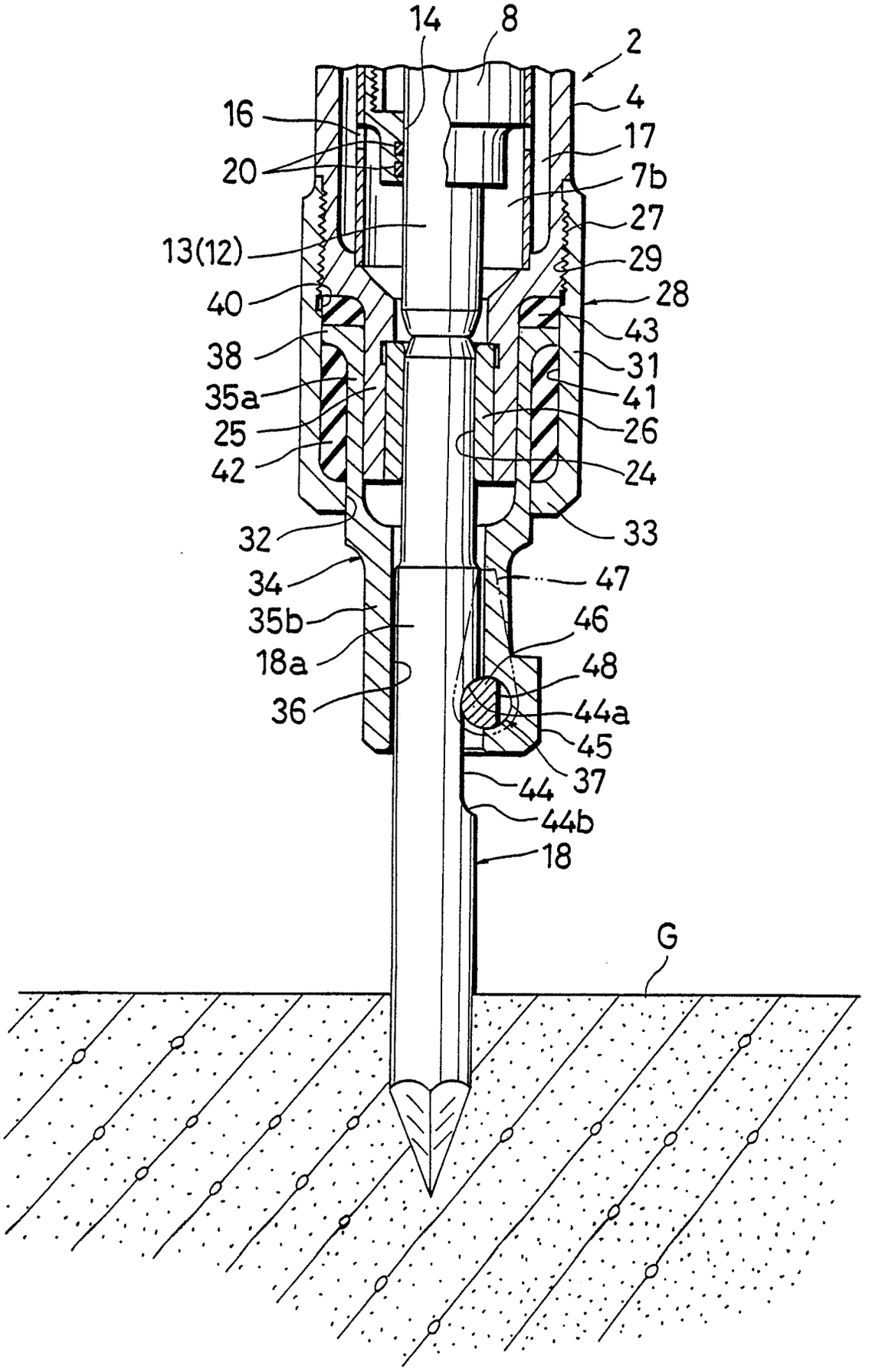
14
8
2
4
16
17
20
7b
27
13(12)
29
40
28
43
38
31
35a
41
25
26
42
24
32
33
34
47
35b
46
18a
48
36
44a
45
37
44
44b
18
G

FIG. 6

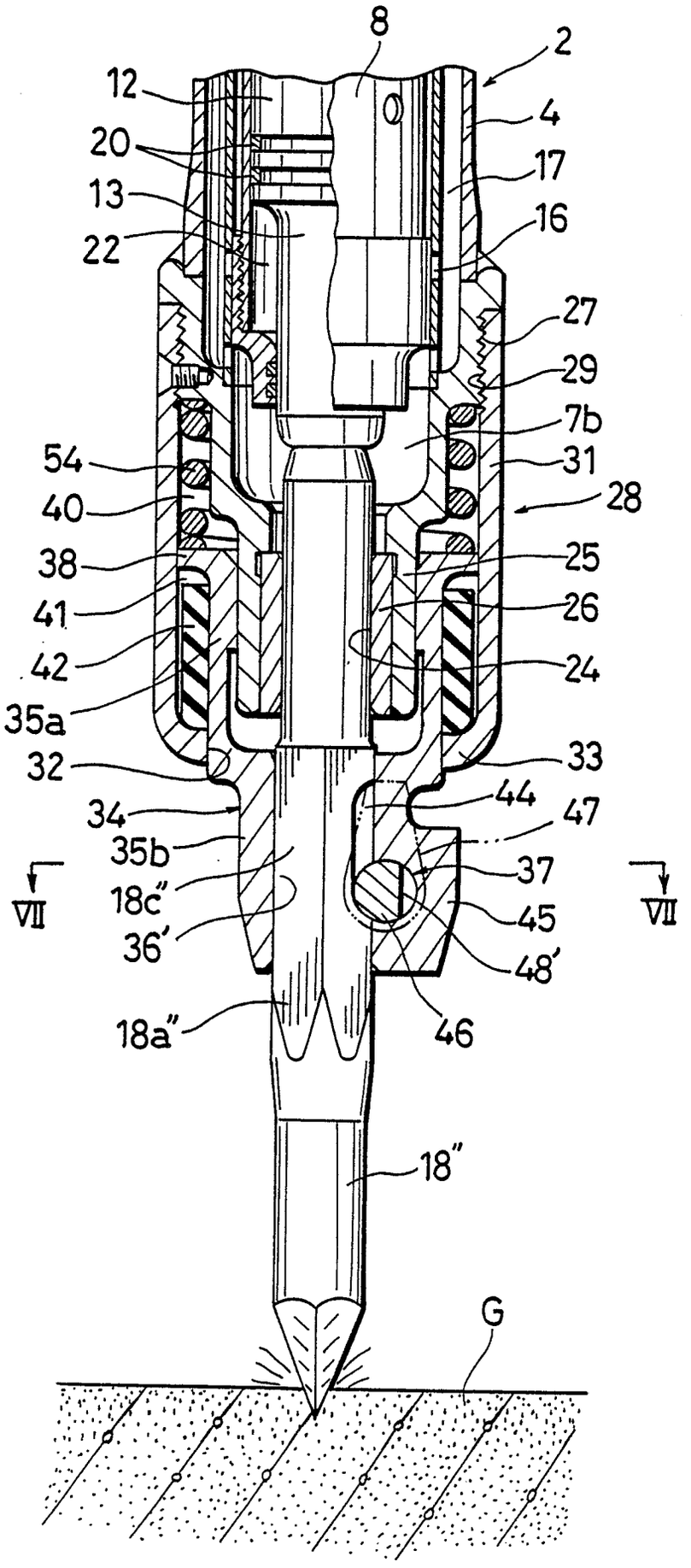
8
2
12
4
20
17
13
16
22
27
29
7b
54
31
40
28
38
25
41
26
42
24
35a
33
32
44
34
47
35b
37
VII
18c"
45
VII
36'
48'
18a"
46
18"
G

FIG. 7

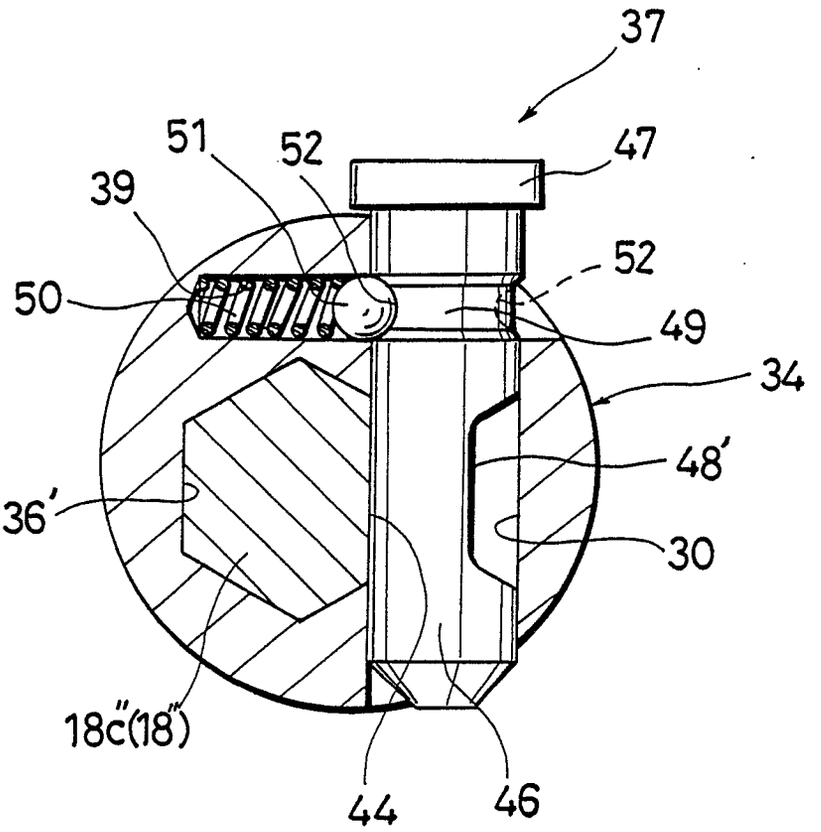

FIG. 8