A portable electric hammer comprising a housing having an electric motor disposed therein. A hollow piston is slideably supported in a barrel and is reciprocated by the motor acting through a drive train. A ram is slideably disposed within the piston and is moved by the piston through alternate suction and compression generated in an air spring between the piston and ram, whereby the ram delivers longitudinal impact blows to a tool bit supported in the front end of the barrel. Improved means is provided to automatically bleed air into the air spring cavity between the ram and the piston to maintain efficient hammer operation, and to automatically de-activate the ram when the tool bit is out of contact with a workpiece.
AIR SPRING BLEED ASSEMBLY

SUMMARY OF THE INVENTION

The present invention resides in an improved telescoping piston and ram construction in a reciprocating hammer mechanism which facilitates air replenishment in an air spring between the piston and ram during use of the mechanism, and which renders the ram inactive (idle) when the tool bit moves far enough forwardly in the housing where it cannot be struck by the ram. The inventive construction embodies the utmost in simplicity, efficiency and reliability.

Main objects, therefore, of the present invention, are to provide an improved bleed and idling assembly for an air spring in a reciprocating hammer mechanism including a ram slideably telescoped within a reciprocating piston and adapted to deliver an impact blow to a tool bit, which assembly efficiently and automatically maintains the air spring between the piston and ram at an optimum level by replenishing air therein during use of the mechanism, and which provides for substantial immobility (idling) of the ram automatically when the tool bit has moved forwardly in the barrel, such as, when the tool bit is out of contact with a workpiece.

Further important objects of the present invention are to provide an improved bleed and idling assembly of the above character which employs a minimum of parts and therefore is relatively inexpensive to manufacture, service and maintain, and yet is highly reliable and efficient in performance.

Other objects and advantages of the present invention will become more apparent from a consideration of the detailed description and claims to follow taken in conjunction with the drawings annexed hereto.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view illustrating a portable electric hammer embodying the present invention;
FIG. 2 is an enlarged, longitudinal sectional view of a portion of FIG. 1 and showing the position of the parts following delivery of an impact blow to a tool bit;
FIG. 3 is a view similar to FIG. 2 showing the position of the parts during compression of the air spring and with the piston and ram moving forwardly toward impact;
FIG. 4 is a view similar to FIGS. 2 and 3 showing the position of the parts at impact;
FIG. 5 is a view similar to FIGS. 2-4 showing the position of the parts with the tool bit out of range to be struck by the ram, and the ram idling;
FIG. 6 is an enlarged sectional view of FIG. 2 taken along the line 6-6 thereof;
FIG. 7 is an enlarged sectional view of FIG. 2 taken along the line 7-7 thereof; and
FIG. 8 is an enlarged sectional view of FIG. 5 taken along the line 8-8 thereof.

BROAD STATEMENT OF THE INVENTION

Broadly described, the present invention relates to a reciprocating hammer mechanism comprising a housing including an elongated barrel, a piston slideably reciprocated in said barrel and interconnected with a drive source, said piston including a hollow tubular forward portion and a closed rear end, a solid ram slideably reciprocated within said piston and adapted to deliver a longitudinal impact blow below to a tool bit supported in said barrel forwardly of said piston, said ram having a substantially continuous peripheral portion sealingly engageable with the inner wall of said piston and forming therewith an air spring within said piston between said peripheral portion and said rear wall, recess means in the inner periphery of said piston and operable to bleed air past said peripheral portion into said air spring during sub-atmospheric condition thereof, port means formed through the wall of said piston and operable to communicate said air spring with the atmosphere when said peripheral portion is adjacent said recess means, said port means being located to communicate directly with said air spring when said tool bit is moved forwardly in said barrel and out of striking range of said ram.

In another aspect, the present invention relates to an air spring bleed and idler assembly for a reciprocating hammer mechanism comprising a barrel having a hollow piston slideable therein, means closing the rear end of said piston, port means extending through the wall of said piston and communicating with the atmosphere, said piston having a smooth inner peripheral surface interrupted by groove means formed therein, said groove means defining a total arc along the inner periphery of said piston substantially less than 180° and located between said port means and said closed end, said ram having a continuous peripheral portion slideably and sealingly engageable with the inner peripheral portion of said piston and having an axial dimension less than the axial dimension of said groove means, said ram being adapted to deliver a longitudinal impact blow to a tool bit supported within said barrel during reciprocation of said piston, said ram peripheral portion being confined for movement within said piston between said port means and said closed end when a tool bit is in position in said barrel, said ram peripheral portion adapted to move outwardly past said port means upon movement of said tool bit forwardly of said barrel and out of position to be struck by said ram, whereby said ram is effectively rendered immobile when said tool bit is located forwardly in said barrel, and whereby said ram is automatically moved to a working position within said piston upon rearward movement of a tool bit into said barrel.

In still another aspect, the present invention relates to a reciprocating hammer mechanism comprising a housing having an elongated barrel formed therein, a motor driven piston in said barrel and having relatively remotely spaced lands slideably engaging said barrel, said piston having a hollow forward portion, port means extending through the wall of said piston portion between said lands, a ram slideable in said hollow piston portion and movable in synchronism therewith to deliver a longitudinal impact blow to a tool bit supported by said housing in the forward end of said barrel, said ram having a substantially continuous annular portion adjacent its rearward end slidingly engaging the inner wall of said piston portion, groove means formed in the inner wall of said piston and defining a total arc of substantially less than 180°, said groove means having an axial length greater than the axial length of said ram annular portion, said ram having a stabilizing lip portion axially spaced forwardly of said annular portion
and slidably engageable with the inner wall of said piston, said lip and annular portion being spaced apart axially a distance greater than the axial distance from said port means to said groove means.

DETAILED DESCRIPTION

Referring now more specifically to the drawings, a portable electric hammer embodying the present invention is illustrated generally at 11 in FIG. 1 and is seen to include a housing comprising an interconnected motor housing 13, gear case 15, barrel 17, and handle 19. An electric motor (not shown) is supported within the motor housing 13 and is powered from a conventional electric power source connected thereto by means of a line cord 21. A suitable on-off trigger switch 23 is provided on the handle 19 for convenient operator control of the tool.

The motor (not shown) has an output rotary shaft (not shown) interconnected by a gear train (not shown) with a rotatable crank 25 supported within the gear case 15 by a bearing 27 (see FIG. 2). A crank pin 29 is fixed to the crank 25 and is rotatably interconnected with one end of a connecting rod 31. The other end of the connecting rod 31 is coupled by a piston pin 33 to a piston 35 formed with longitudinally spaced lands 36, 38 slidably disposed within the barrel 17.

As shown, the piston 35 includes a closed rear wall 37 and an elongated skirt 39 extending forwardly therefrom. A solid ram 41 is telescoped within the piston skirt 39 and has a forward end portion 43 adapted to impact against and deliver a longitudinal impact blow to a tool bit 45 supported in a bit holder 46 in the front end of the barrel 17. A retainer yoke 47 is fixed to retainer rods 49, 51 which in turn are resiliently supported upon the barrel 17 by coil compression springs 53, 55 and prevents the bit 45 from coming out of the barrel 17.

In use of the hammer, the electric motor, acting through the gear train, crank 25 and connecting rod 31, reciprocates the piston 35 within the barrel 17. The ram 41 is also caused to reciprocate, by means of alternate suction and compression of an air spring within an air spring cavity 57 defined by the ram 41, the piston wall 37, and the tubular piston skirt 39. In so reciprocating, the forward end 43 of the ram 41 impacts against the rear end of the tool bit 45.

The ram 41 has a continuous peripheral portion 63 which slideably and sealingly engages the inner periphery 65 of the piston skirt 39. If desired, an annular groove 67, formed in the portion 63 of the ram 41, may carry a seal ring 69. The ram 41 may also have a lip 68 positioned forwardly of the peripheral portion 63 to help stabilize the ram 41 in the piston 35.

It will be appreciated that during use of the hammer 11, some air leakage will occur across the sealing portion of the ram 41 and even across the seal 69 if one is employed, and that this provides an undesirable variable in the performance of the air spring and of the tool 11. It is, therefore, necessary to provide an air bleed to replenish air within the air spring cavity 57 during use of the tool 11. To this end, the piston skirt 39 has a plurality of radial ports 71 extending therethrough. The piston lands 36, 38 are provided with flats 40 which communicate the atmosphere with the ports 71, and therefore with the interior of the piston skirt 39. In addition, the inner peripheral surface 65 of the piston skirt 39 is interrupted by a plurality of recess means or grooves 73 formed therein. The combined cross sectional area of the ports 71 is related to that of the grooves 73 so as not to restrict flow (bleed) of air through the grooves 73 to the air spring cavity 57. Also, the combined cross sectional area of the groves 73 is large enough (e.g., larger than the clearance between the ram sealing portion 59 and piston wall 65, or the ring gap in sealing ring 69) to insure that any air lost during compression of the air spring can be replenished during bleeding. Further, the grooves 73 have an axial dimension greater than the axial dimension of the sealing portion 63 of the ram 41 so that the atmosphere is communicated with the air spring cavity 57 by way of the ports 71 and the grooves 73 when the sealing portion 63 of the ram 41 is adjacent the grooves 73. Thus, when the air spring cavity 57 is under sub-atmospheric conditions, which occurs in the return stroke of the piston 35 and after impact of the ram 41 against the tool bit 45 as will be described, air is drawn (bled) into the cavity 57.

The sequence of operation for the construction of the present invention is illustrated in FIGS. 2-4. FIG. 2 shows the position of the parts following delivery of an impact blow by the ram 41 against the tool bit 45. Here, the piston 35 has already begun its return movement under the action of the crank pin 29 and connecting rod 31, while the ram 41, at this stage, is rebounding in the same direction as the piston 35 following the impact blow. Continued return movement of the piston 35 causes it to overrun the rebound movement of the ram 41 as it begins to slow and the piston 35 then moves relative to the ram 41 in the return direction.

When the sealing portion 63 of the ram 41 moves into a position adjacent the grooves 73, air is drawn in from the atmosphere through the ports 71, along the grooves 73, and into the air spring cavity 57. Preferably, the distance from the lip 68 to the seal portion 63 is greater than the distance from the bleed ports 71 to the grooves 73. Continued return movement of the piston 35 moves the grooves 73 past the sealing portion 63 so that the sealing portion 63 is between the grooves 73 and the ports 71. At this point, the cavity 57 is again sealed.

When the crank pin 29 reaches top dead center, the direction of movement of the piston 35 reverses. For a short time, the ram 41 continues return movement (under momentum) into the piston skirt 39 and causes the sealing portion 63 to again move past the grooves 73. The air spring 57, now under compression, causes the ram 41 to rapidly accelerate and move with the piston 35 and toward the tool bit 45. When the crank pin 29 reaches bottom dead center, return movement of the piston 35 begins. The ram 41, however, if it has not already struck the bit 45, continues to move toward the tool bit 45 under its momentum and delivers a high energy impact blow to the rear end of the tool bit 45. Continued return movement of the piston 35 again develops a suction or sub-atmospheric pressure condition within the air spring cavity 57 and this, together with the rebound action of the ram 41, causes the ram to retract away from the tool bit 45 and the operation is repeated.
The position of the bleed grooves 71 along the piston skirt 39 is such that when a tool bit 45 is in position within the barrel 17, the sealing portion 63 of the ram 41 will not uncover the ports 71. Thus, the ram 41 will move synchronously with the piston 35. However, when the tool bit 45 moves forwardly of the holder 46, such as when the bit no longer engages a work surface, the ram 41, in moving forwardly with the piston 35, uncovers the ports 71 during at least a major portion of the cycle. Now the piston 35 will not carry the ram 41 with it during the return stroke since the vacuum in the air spring cavity 57 is broken and substantially atmospheric conditions exist therein. Thus, the ram 41 remains substantially immobile and fully extended toward the front of the barrel 17, although still within the skirt 39 (see FIG. 5). This condition, known as idling, is advantageous in that the ram 41 will not continue to beat on the tool bit holder 46 should the tool continue to operate after the bit 45 is out of contact with the work surface. When the tool bit 45 is pushed back into the barrel 17, the ram 41 is pushed axially into the piston skirt 39 and the sealing portion 63 past the ports 71. Now, when the piston 35 is reciprocated, alternate suction and compression in the air spring cavity 57 causes the ram 41 to reciprocate.

It will be appreciated that the ram 41 and piston 35 reciprocate together throughout a great portion of the piston stroke so that friction losses between these two members are minimized. Friction drag losses between the piston 35 and the barrel 17 are further minimized by limiting surface area contact therebetween to the remotely spaced piston lands 36, 38 and, of course, careful selection of lubrication.

It has been discovered that by properly dimensioning the grooves 73, and positioning the sealing portion 63, the ports 71, and the grooves 73, the efficiency of the air spring and that of the hammer 11, is maximized, as is the performance of the tool 11. By way of example, it has been discovered that by utilizing a plurality of spaced grooves 73 each of which extends through an arc of approximately 8° or less, wherein the combined arcuate dimension of the grooves 73 is not more than approximately 45°, sufficient air can be bled into the air spring cavity 57 during suction to maintain the desired air spring conditions without detracting from the energy delivered to the ram 41 during air spring compression.

Also by way of example, the total cross section of the ports 71 may be somewhat greater than that of the grooves 73, if the volume between the ram lands 36, 38 is not sufficient, so that air intake to the air spring cavity during bleeding is controlled by the cross section of the grooves 73. The ports 71 are positioned so that the sealing portion 63 of the ram 41 can move forwardly thereof only when the tool bit 45 is forwardly of the holder 46. Thus, during normal tool operation (with the tool bit 45 extending rearwardly of the holder 46), the ports 71 communicate with the air spring cavity 57 only by means of the grooves 73.

Also, the grooves 73 are dimensioned and positioned so as to prevent the ram 41 from bottoming in the piston 39 and to allow the sealing portion 63 to move therepast during both the suction and compression strokes.

Finally, the ram 41 is a solid member requiring no through openings or ports. Only the peripheral surface 63 requires machining and this greatly reduces the overall cost of the mechanism.

By the foregoing, there has been disclosed an improved air spring bleed and idler assembly for a reciprocating hammer calculated to fulfill the intensive objects hereinabove set forth, and while a preferred embodiment of the present invention has been illustrated and described in detail, various additions, substitutions, modifications and omissions may be made thereto without departing from the spirit of the invention.

We claim:

1. A reciprocating hammer mechanism comprising a housing including an elongated barrel, a piston slidably reciprocated in said barrel and interconnected with a drive source, said piston including a hollow tubular forward portion and a closed rear end, a solid ram slidably reciprocated within said piston and adapted to deliver a longitudinal impact blow to a tool bit supported in said barrel forwardly of said piston, said ram having a substantially continuous peripheral portion sealingly engageable with the inner wall of said piston and forming therewith an air spring within said piston between said peripheral portion and said rear wall, recess means in the inner periphery of said piston and operable to bleed air past said peripheral portion into said air spring during sub-atmospheric condition thereof, port means formed through the wall of said piston and operable to communicate said air spring with the atmosphere when said peripheral portion is adjacent said recess means, said port means being located to communicate directly with said air spring when said tool bit is moved forwardly in said barrel and out of striking range of said ram.

2. An air spring bleed and idler assembly for a reciprocating hammer mechanism comprising a barrel having a hollow piston slideable therein, means closing the rear end of said piston, port means extending through the wall of said piston and communicating with the atmosphere, said piston having a smooth inner peripheral surface interrupted by groove means formed therein, said groove means defining a total arc along the inner periphery of said piston substantially less than 180° and located between said port means and said closed end, said ram having a continuous peripheral portion slideably and sealingly engageable with the inner peripheral portion of said piston and having an axial dimension less than the axial dimension of said groove means, said ram being adapted to deliver a longitudinal impact blow to a tool bit supported within said barrel during reciprocation of said piston, said ram peripheral portion being confined for movement within said piston between said port means and said closed end when a tool bit is in position in said barrel, said ram peripheral portion adapted to move outwardly past said port means upon movement of said tool bit forwardly of said barrel and out of position to be struck by said ram, whereby said ram is effectively rendered immobile when said tool bit is located forwardly in said barrel, and whereby said ram is automatically moved to a working position within said piston upon rearward movement of a tool bit into said barrel.
3. A mechanism as defined in claim 1 wherein the cross sectional area of said recess means is less than the cross sectional area of said port means.

4. A mechanism as defined in claim 1 wherein said recess means has an axial length greater than said peripheral portion.

5. A mechanism as defined in claim 1 wherein said recess means includes a plurality of grooves each of which defines a peripheral angle of approximately 8° or less, said grooves together defining a peripheral angle of substantially 45° or less.

6. A mechanism as defined in claim 1 wherein said port means is positioned so that said peripheral portion of said ram cannot move therepast when a tool bit is in place in said barrel, said peripheral portion being adapted to move past said port means where said tool bit is moved forward in said barrel and out of range to be struck by said ram.

7. A mechanism as defined in claim 1 wherein said peripheral portion and said recess means are positioned so that said peripheral portion moves past said recess means to vent said air spring during both suction and compression strokes of said piston.

8. An assembly as defined in claim 2 wherein said groove means defines a total arc of substantially 45° or less.

9. An assembly as defined in claim 2 wherein said groove means includes a plurality of grooves each of which defines a peripheral angle of substantially 8° or less.

10. A reciprocating hammer mechanism comprising a housing having an elongated barrel formed therein, a motor driven piston in said barrel and having relatively remotely spaced lands slideably engaging said barrel, said piston having a hollow forward portion, port means extending through the wall of said piston portion between said lands, a ram slideable in said hollow piston portion and movable in synchronism therewith to deliver a longitudinal impact blow to a tool bit supported by said housing in the forward end of said barrel, said ram having a substantially continuous annular portion adjacent its rearward end slidingly engaging the inner wall of said piston portion, groove means formed in the inner wall of said piston and defining a total arc of substantially less than 180°, said groove means having an axial length greater than the axial length of said ram annular portion, said ram having a stabilizing lip portion axially spaced forwardly of said annular portion and slideably engageable with the inner wall of said piston, said lip and annular portion being spaced apart axially a distance greater than the axial distance from said port means to said groove means.

11. A hammer as defined in claim 10 wherein said lands are formed with flats defining air passages communicating said port means with the atmosphere.

12. A hammer as defined in claim 10 wherein said groove means includes a plurality of grooves which define a total arc of less than 45°.

13. A hammer as defined in claim 10 wherein the total cross sectional area of said groove means is less than the total cross sectional area of said port means.

14. A hammer as defined in claim 10 wherein the cross sectional area of said groove means is greater than the clearance between said substantially continuous annular portion of said ram and the inner wall of said piston portion.

15. A hammer as defined in claim 14 wherein said portion includes a split sealing ring engaging the wall of said piston, said clearance being defined by a gap between the ends of said ring.