This invention relates to motor powered pneumatic impact tools and is particularly concerned with a motor powered air hammer for heavy duty work.

For many years there has been a need for a versatile, portable and durable heavy duty impact tool suitable for use in demolition work, frost breaking, tamping, pavement breaking, under water excavation work, pile driving, tie tamping, slag breaking, and tunneling. These various applications arise in numerous different industries including quarry operations, mining, railroad, steel mills and public utility and contracting operations.

In the past numerous different devices have been employed in these operations including steam or diesel powered pile drivers, mechanically operated portable drop hammers, swinging frost balls, spring actuated hammers, and various types of pneumatic tools, and these have been inadequate for various reasons including unduly complex designs involving expensive fuel pumps, nozzles and valves, inability to operate in various different positional orientations, difficulty in adjustment of the impact level, and unduly expensive and bulky auxiliary equipment such as steam boilers and steam lines in the case of steam powered pile drivers.

The principal object of the invention is to provide an improved motor powered air hammer characterized by a simple and rugged design that lends itself to portability and to quick attachment and detachment to a power source.

Another object of the invention is to provide a motor powered air hammer employing an adjustable air pressure system to enable accurate adjustment and control of the impact level.

A further object of the invention is the provision of a motor powered air hammer of compact form that may be connected to the hydraulic system of conventional hydraulic excavator equipment and that may be mounted to the boom of the excavator for ease in transporting the device.

Still another object of the invention is the provision of a motor operated air hammer having a minimum of parts and eliminating fatigue failure such as is usually associated with equipment where high stresses are repeatedly applied.

Other objects and advantages of the present invention will be apparent from the following descriptions and claims, and are illustrated in the accompanying drawings which show structure embodying preferred features of the present invention and the principles thereof, and what is now considered to be the best mode in which to apply these principles.

In the accompanying drawings forming part of this specification, and in which like numerals are employed to designate like parts throughout the same,

FIG. 1 is a side elevational view of a motor powered air hammer constructed in accordance with this invention, with parts of the drive housing broken away and sectioned along the line 1-1 of FIG. 2 to facilitate disclosure;

FIG. 2 is a lengthwise sectional view through the unit and includes a diagrammatic representation of a pressurized air system which is employed to establish and enable adjustment of the impact level developed by the tool; and

FIG. 3 is a transverse sectional view through the drive housing and is taken as indicated on the line 3-3 of FIG. 1.

Referring now to the drawings, the overall arrangement of the impact tool of this invention includes an elongated main slide barrel 10 having an anvil guide housing 11 fixed thereto at one end in endwise alignment therewith and having a drive housing 12 fixed at its other end and also arranged in endwise alignment with the barrel. The barrel 10 has integral end flanges 10F, one being in bolted assembly to an integral end flange 11F provided on the anvil guide housing 11 and the other being in bolted assembly directly to the drive housing 12. An anvil shaft 13 is carried in the anvil guide housing 11 and projects endwise therethrough to contact the material to be impacted. The anvil shaft 13 is formed with an integral anvil cup 13C of enlarged form which is fitted with a cushion insert 14 of brass or lead, and a ring 15 of resilient material such as molded urethane rubber is disposed between the anvil 13C and the lower end 11E of the anvil guide housing 11 to function as a shock absorber. These cushioning facilities associated with the anvil 11 prevent severe shock effects between hard metal parts and minimize failure problems under heavy duty loading cycles.

In the preferred form illustrated herein, a hammer shaft 15 is reciprocably slidable through the barrel 10 and through the drive housing 12 and is operable to apply endwise impacts to the anvil shaft 13, such impacts being transmitted through the cushion insert 14 that is nested in the anvil cup 13C. The upper portion 15R of the hammer shaft extends through the drive housing 12 and is of reduced diameter to receive a case hardened steel retainer sleeve 16 and a steel T-bar head 17 located to occupy an intermediate region of the drive housing 12. A lower guide bearing 18 is illustrated as being provided integral with the drive housing 12 to seat in the upper end of the barrel 10 and an upper guide bearing 19 is mounted to the upper end wall 12U of the guide housing and is encased by means of a cover housing 20. The guide bearings 18 and 19 provide balanced bearing support for guiding the movement of the hammer shaft assembly which comprises the hammer shaft 15, the sleeve 16 and the T-head 17. The upper end of the hammer shaft 15 is threaded as indicated at 15T and receives a lock nut 21 to hold the sleeve 16 and T-bar 17 in fixed position with the sleeve 16 riding against the upper guide bearing 19 and with the main hammer shaft 15 riding in the lower guide bearing 18.

In accordance with this invention an air spring is incorporated in the tool by providing a compression chamber 22 within the upper end of the barrel 10. For this purpose O-ring seals 23 and 24, respectively, are provided to complete a seal between the barrel 10 and the drive housing 12 and between the lower guide bearing 18 and the hammer shaft 15. In addition, the lower guide bearing 18 is equipped at its upper end with an oil seal 25 and thus the lower guide bearing serves as a stationary end cap or end wall defining one limit of the compression chamber 22. To complete the compression chamber, a piston 26 which may be of alloy steel is mounted in loose but stable relation upon an enlargement 15E near the lower end of the hammer shaft 15. Teflon seal rings 27 and 28, respectively, are employed to complete the seal between the piston 26 and the slide barrel 10 and between the piston 26 and the hammer shaft 15. While the piston has a floating relation on the hammer shaft, the mounting configuration of these parts in a pressurized chamber is such that the piston 26 normally maintains a fixed relationship to the shaft 15 during shaft movement in either direction. A cushion ring 29 of molded urethane rubber encircles the lower end of the hammer.
shaft and a keeper plate 30 in the form of a steel ring retains this cushion ring, with the keeper plate 30 being seated against an internal peripheral shoulder 10S provided within the barrel, and the keeper plate, in turn, being locked in place by a split ring 30R that nests in a lock groove provided in the slide barrel.

Finally, another cushion ring 32 of molded urethane rubber is encircled on the hammer shaft 15 on the lower side of the keeper plate 30 and a second keeper plate 33 in the form of a steel ring is provided within the extreme lower end of the slide barrel 10 to be positioned between the second cushion ring 32 and an annular internal shoulder 11S that is provided on the anvill guide housing 11.

The compression chamber 22 of the air spring has an inlet port 34 which is illustrated as a side wall opening of the slide barrel to receive an air feed line 35 leading from a pressurized tank or air accumulator 36 which may typically have air stored under a pressure of 100 p.s.i. This air feed line 35 has an adjustable pressure reducing valve 37 and a check valve 38 to accommodate one-way infed flow of air to the compression chamber 22. The pressure valve of the air fed to the compression chamber 22 may be selected at any value within the limit established by the accumulator and, by way of example, in a typical operating situation, a value of 20 p.s.i. may be employed.

One of the important features of this invention is that by simple adjustment of the pressure reducing valve 37, the minimum pressure maintained within the compression chamber 22 is accordingly adjusted, thereby determining the energy storage capacity of the compression chamber 22 and correspondingly, the impact energy level of the tool, all without need for varying the stroke length. Thus, adjustment of the operating energy level of the tool is accomplished without complicated mechanisms within the tool itself, and this simplifies its construction and leads to a more durable, longer-lived tool.

Since a constant stroke arrangement simplifies the drive system, numerous types of drives will occur to those skilled in this art for effecting repeated retraction and release of the hammer shaft 15. For purposes of illustrative disclosure, however, a preferred drive arrangement is illustrated herein wherein the T-bar head 17 is employed to present a pair of abutments 17A which are located in flanking relation to the hammer shaft 15. A spur gear shaft 40 is disposed crosswise in the drive housing 12 and has its opposite ends journalled in wall mounted bearings 41 carried by the drive housing. A pair of spur gears 42 are keyed to the spur gear shaft 40 in spaced relation to flank the hammer shaft 15. Each of these spur gears 42 rotatably supports a pair of heavy cam rollers 43 symmetrically positioned on a diametral line through the axis of the spur gear shaft 40. The spur gears 42 and their cam rollers 43 are mounted to operate in unison in engaging the abutments 17A presented by the T-head.

A pinion shaft 44 extends crosswise in spaced parallel relation to the spur gear shaft 40 and has its ends journalled in wall mounted bearings 45 carried by the drive housing. The pinion shaft 44 is equipped with a pair of pinion gears 46 spaced to mesh with corresponding ones of the spur gears 42 for driving the same in uniformly timed relation. The pinion shaft 44 is, in turn, equipped with a worm gear 47 which is preferably integral. A motor 48 is shown mounted outboard on the drive housing 12 in FIG. 1 and the motor shaft 48S is represented in FIG. 3 as and shown therein is coupled to a worm shaft 49 which, in turn, drives the worm gear 47 on the pinion shaft, and through the pinion gear 43 drives the spur gears 42. In the preferred form illustrated herein, a total gear reduction ratio of 60 to 1 is provided.

In FIGS. 1 and 2 the hammer shaft 15 and its T-bar head 17 are shown in the “start” or “down” position, and in FIGS. 2 and 3 the cam roll bearings 43 are shown in the position wherein the T-head 17 is about to be picked up at the beginning of the retraction stroke.

In FIG. 1, for purposes of illustration, the cam rollers 43 are shown at an intermediate position wherein the left hand cam rollers have released the T-head and the power stroke has been completed but the right hand cam rollers have not yet picked up the T-head for retracting the hammer shaft.

FIG. 2 illustrates in phantom lines the maximum lift position for the T-head 17 and for the pair of cam roll bearings 43. Further rotation of the spur gears in the direction of the arrow shown thereon in FIG. 2 would produce the phantom line cam roll bearing 43 free of the T-head 17 and at this time the stored energy in the air spring will act against the piston and drive the hammer shaft through its power stroke and into impacting relation against the anvil 13 which will, at this time, be spaced above the shock absorber ring 15 against which it bottoms at the end of the power stroke. It should be noted that a single cam roller 43 upon each spur gear is sufficient but the use of two doubles the cycle rate of operation and eliminates dead time from the operating cycle.

In the preferred form, the hydraulic type, it being contemplated that the unit may be mounted on the boom of any hydraulic excavator having a hydraulic system capable of providing a flow capacity in the range from 20 gallons per minute to 50 gallons per minute at 1500 p.s.i. or greater. If desired, or appropriate, an electric motor may be substituted.

For the illustrated arrangement, the top dead center position for the piston is indicated by the dashed line 50 appearing in FIG. 2 and this provides a compression ratio for the air spring of 6 to 1. Exhaust ports 51 are shown in the side walls of the barrel to facilitate rapid power travel of the hammer shaft, with these exhaust ports 51 being covered and sealed by the piston 26 when the tool is at its “start” position as illustrated in the drawings.

Thus, while preferred constructional features of the invention are embodied in the structure illustrated herein, it is to be understood that changes and variations may be made by those skilled in the art without departing from the spirit and scope of the appended claims.

What is claimed is:

1. A motor powered pneumatic impact tool comprising a main slide barrel having anvil guide housing structure at one end, an anvil shaft carried in said anvil guide housing structure and projecting therethrough, a hammer shaft reciprocably slidable through said barrel to apply endwise impacts to said anvil shaft, means defining a compression chamber within said barrel and including a piston fixedly mounted on said hammer shaft to operate in sealing slidable relation in said barrel and means completing an air seal at the other end of the barrel, means for supplying air to said compression chamber to maintain a predetermined minimum pressure therein, a motor mounted in fixed relation to said barrel, and mechanical means connecting said motor and operated repeatedly first to shift said hammer shaft to move said piston towards said other end of the barrel for multiplying pressure in said compression chamber and thereafter to release said hammer shaft to enable expansion of said chamber to drive the hammer shaft against the anvil shaft, said means for supplying air comprising an air accumulator for storing air at a predetermined pressure level above a desirable pressure level, said accumulator interconnected between said air accumulator and said compression chamber for supplying air to said compression chamber at a selected pressure level below said predetermined air accumulator pressure level, and a one way valve interconnected between said adjustable means and said compression chamber to permit flow of air into said compression chamber while preventing increased
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pressure in said compression chamber during compression from influencing said adjustable means.

2. A motor powered pneumatic impact tool comprising a main slide barrel having anvil guide housing structure at one end, an anvil shaft carried in said anvil guide housing structure and projecting therethrough, a hammer shaft reciprocably slidable through said barrel to apply endwise impacts to said anvil shaft, means defining a compression chamber within said barrel and including a piston fixedly mounted on said hammer shaft to operate in said compression chamber while preventing increased pressure in said compression chamber during compression from influencing said adjustable means, a motor mounted to fixed relation to said barrel, and mechanical means connecting said motor and operable repeatedly first to shift said hammer shaft to move said piston towards said other end of the barrel for multiplying pressure in said combustion chamber and therefrom to release said hammer shaft to enable expansion of said chamber to drive the hammer shaft against the anvil shaft.

3. A motor powered pneumatic impact tool comprising a main slide barrel having anvil guide housing structure at one end and drive housing structure at the other end, an anvil shaft carried in said anvil guide housing structure and projecting therethrough, a hammer shaft reciprocably slidable through said barrel to apply endwise impacts to said anvil shaft, means defining a compression chamber within said barrel and including a piston fixedly mounted on said hammer shaft to operate in said compression chamber while preventing increased pressure in said compression chamber during compression from influencing said adjustable means, a motor mounted to fixed relation to said barrel and end cap bearing means at the other end of the barrel and guiding said hammer shaft to complete an air seal for said compression chamber, a source of air under pressure external of said barrel, adjustable pressure reducing means for supplying air from said source to said compression chamber to maintain a predetermined minimum pressure therein, said source of air comprising an air accumulator for storing air at a predetermined pressure level above atmospheric pressure, said adjustable pressure reducing means being interconnected between said air accumulator and said compression chamber and supplying air to said compression chamber at a selected pressure level below said predetermined air accumulator pressure level, and a one way valve interconnected between said adjustable means and said compression chamber to permit the flow of air into said compression chamber while preventing increased pressure in said compression chamber during compression from influencing said adjustable means, said hammer shaft having abutment means carried rigidly at a portion thereof that is within said drive housing structure, a motor mounted to said drive housing structure and having a drive shaft rotatable therein, cam means mounted in said drive housing structure and connected to be cyclically driven by said drive shaft to repeatedly establish one way shifting movement of said abutment means and thereby retract the hammer shaft a predetermined distance from said anvil shaft from multiplying pressure in said chamber and enable expansion of said chamber to drive the hammer shaft against the anvil shaft.

4. A motor powered pneumatic impact tool comprising a main slide barrel having anvil guide housing structure at one end and drive housing structure at the other end, an anvil shaft carried in said anvil guide housing structure and projecting therethrough, a hammer shaft reciprocably slidable through said barrel to apply endwise impacts to said anvil shaft, means defining a compression chamber within said barrel and including a piston fixedly mounted on said hammer shaft to operate in said compression chamber while preventing increased pressure in said compression chamber during compression from influencing said adjustable means, a motor mounted to fixed relation to said barrel and end cap bearing means at the other end of the barrel and guiding said hammer shaft to complete an air seal for said compression chamber, a source of air under pressure external of said barrel, adjustable pressure reducing means for supplying air from said source to said compression chamber to maintain a predetermined minimum pressure therein, said source of air comprising an air accumulator for storing air at a predetermined pressure level above atmospheric pressure, said adjustable pressure reducing means being interconnected between said air accumulator and said compression chamber and supplying air to said compression chamber at a selected pressure level below said predetermined air accumulator pressure level, and a one way valve interconnected between said adjustable means and said compression chamber to permit the flow of air into said compression chamber while preventing increased pressure in said compression chamber during compression from influencing said adjustable means, said hammer shaft having abutment means carried rigidly at a portion thereof that is within said drive housing structure, a motor mounted to said drive housing structure and having a drive shaft rotatable therein, cam means mounted in said drive housing structure and connected to be cyclically driven by said drive shaft to repeatedly establish one way shifting movement of said abutment means and thereby retract the hammer shaft a predetermined distance from said anvil shaft from multiplying pressure in said chamber and enable expansion of said chamber to drive the hammer shaft against the anvil shaft.

5. A motor powered pneumatic impact tool comprising a main slide barrel having anvil guide housing structure at one end and drive housing structure at the other end, an anvil shaft carried in said anvil guide housing structure and projecting therethrough, a hammer shaft reciprocably slidable through said barrel to apply endwise impacts to said anvil shaft, means defining a compression chamber within said barrel and including a piston fixedly mounted on said hammer shaft to operate in said compression chamber while preventing increased pressure in said compression chamber during compression from influencing said adjustable means, a motor mounted to fixed relation to said barrel and end cap bearing means at the other end of the barrel and guiding said hammer shaft to complete an air seal for said compression chamber, a source of air under pressure external of said barrel, adjustable pressure reducing means for supplying air from said source to said compression chamber to maintain a predetermined minimum pressure therein, said source of air comprising an air accumulator for storing air at a predetermined pressure level above atmospheric pressure, said adjustable pressure reducing means being interconnected between said air accumulator and said compression chamber and supplying air to said compression chamber at a selected pressure level below said predetermined air accumulator pressure level, and a one way valve interconnected between said adjustable means and said compression chamber to permit the flow of air into said compression chamber while preventing increased pressure in said compression chamber during compression from influencing said adjustable means, said hammer shaft having abutment means carried rigidly at a portion thereof that is within said drive housing structure, a motor mounted to said drive housing structure and having a drive shaft rotatable therein, cam means mounted in said drive housing structure and connected to be cyclically driven by said drive shaft to repeatedly establish one way shifting movement of said abutment means and thereby retract the hammer shaft a predetermined distance from said anvil shaft from multiplying pressure in said chamber and enable expansion of said chamber to drive the hammer shaft against the anvil shaft.
comprising a plurality of non-contiguous members of high shock absorptive material.

6. A motor powered pneumatic impact tool comprising a main slide barrel, a hammer shaft reciprocably slideable through said barrel to apply endwise impacts through one end of the slide barrel, means defining a compression chamber within said barrel and including a piston fixedly mounted on said hammer shaft to operate in sealing slidable relation in said barrel and means completing an air seal at the other end of the barrel, means for supplying air to said compression chamber to maintain a predetermined minimum pressure therein, a motor mounted in fixed relation to said barrel, and mechanical means connecting said motor and hammer shaft and operable repeatedly first to shift said hammer shaft to move said piston towards said other end of the barrel for multiplying pressure in said combustion chamber and thereafter to release said hammer shaft to enable expansion of said chamber to drive the hammer shaft through a power stroke, said means for supplying air comprising an air accumulator for storing air at a predetermined pressure level above atmospheric pressure, adjustable pressure reducing means interconnected between said air accumulator and said compression chamber for supplying air to said compression chamber at a selected pressure level below said predetermined air accumulator pressure level, and a one way valve interconnected between said adjustable means and said compression chamber to permit the flow of air into said compression chamber while preventing increased pressure in said compression chamber during compression from influencing said adjustable means.

7. A motor powered pneumatic impact tool comprising a main slide barrel, a hammer shaft reciprocably slideable through said barrel to apply endwise impacts through one end of the slide barrel, means defining a compression chamber within said barrel and including a piston fixedly mounted on said hammer shaft to operate in sealing relation in said barrel and means completing an air seal at the other end of the barrel, a source of air under pressure external of said barrel, adjustable pressure reducing means for supplying air from said source to said compression chamber to maintain a predetermined minimum pressure therein, said source of air comprising an air accumulator for storing air at a predetermined pressure level above atmospheric pressure, said adjustable pressure reducing means being interconnected between said air accumulator and said compression chamber and supplying air to said compression chamber at a selected pressure level below said predetermined air accumulator pressure level, and a one way valve interconnected between said adjustable means and said compression chamber to permit the flow of air into said compression chamber while preventing increased pressure in said compression chamber during compression from influencing said adjustable means, a motor mounted in fixed relation to said barrel, and mechanical means connecting said motor and hammer shaft and operable repeatedly first to shift said hammer shaft to move said piston towards said other end of the barrel for multiplying pressure in said combustion chamber and thereafter to release said hammer shaft to enable expansion of said chamber to drive the hammer shaft through a power stroke.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,321,033 May 23, 1967

George J. Benuska et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 5, line 28, for "to" read -- in --; column 6, line 46, before "anvil" insert -- said --.

Signed and sealed this 21st day of November 1967.

(SEAL)

Attest:

Edward M. Fletcher, Jr.
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents