M. A. YEAKLEY.

PNEUMATIC HAMMER.

APPLICATION FILED NOV. 4, 1907.

**1,000,568.** Patented Aug. 15, 1911.

2 SHEETS—SHEET 1.

Fig 1

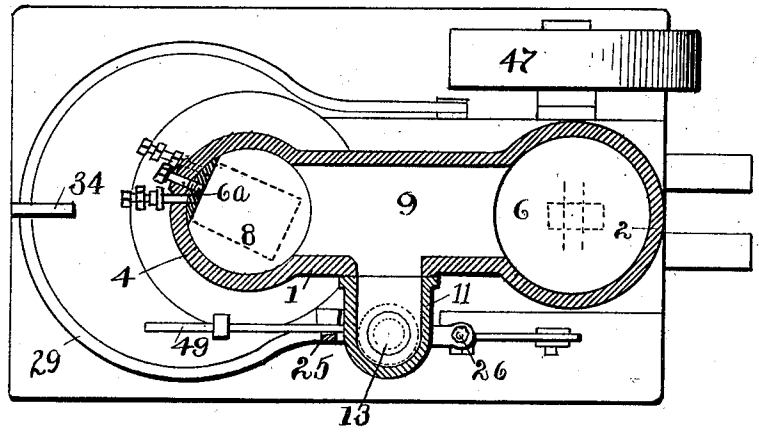
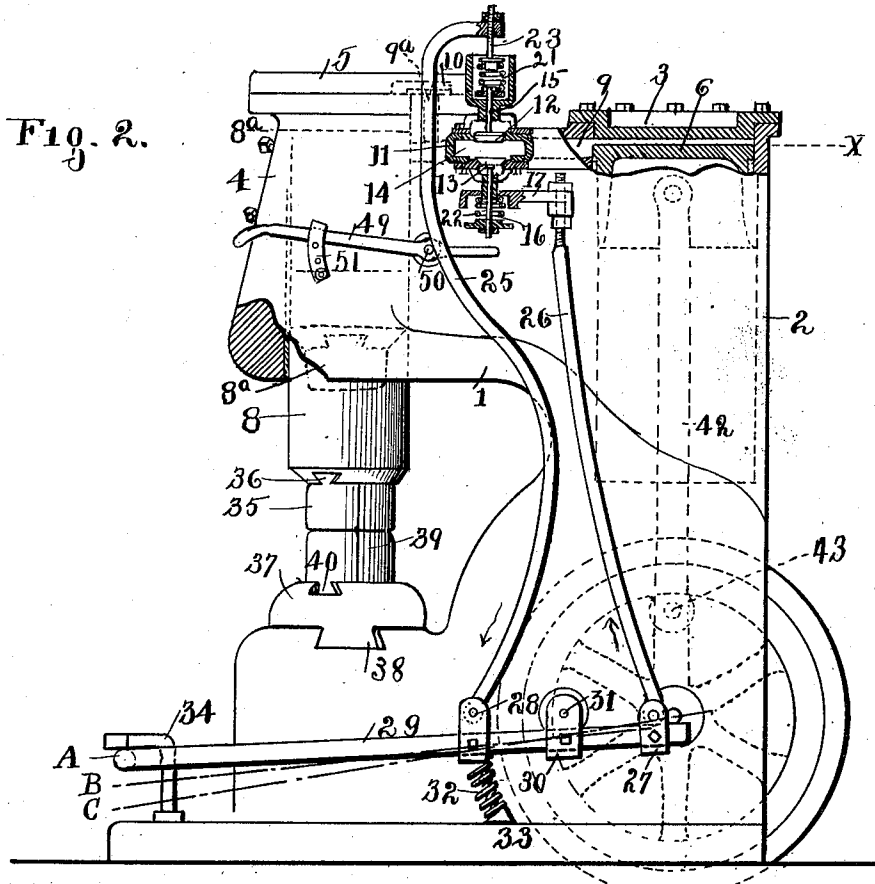



Fig. 2.

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2 SHEETS—SHEET 2.

Fig. 3

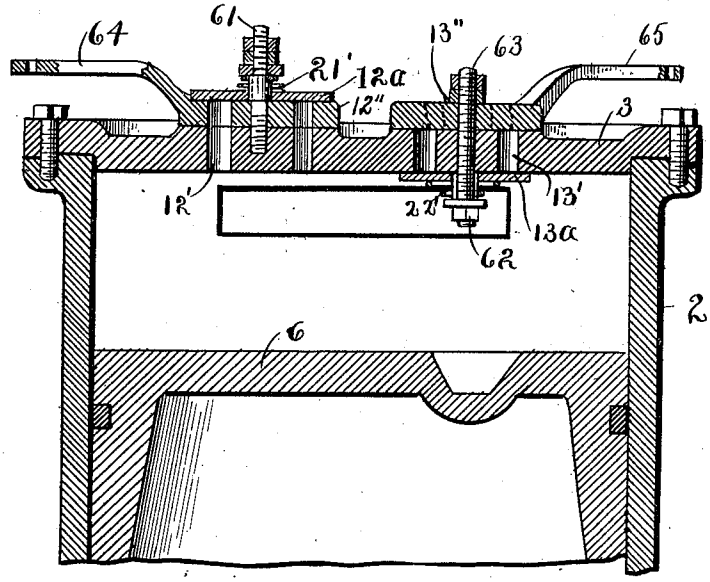



Fig. 4

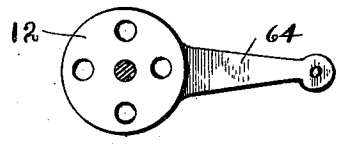



Fig. 6.

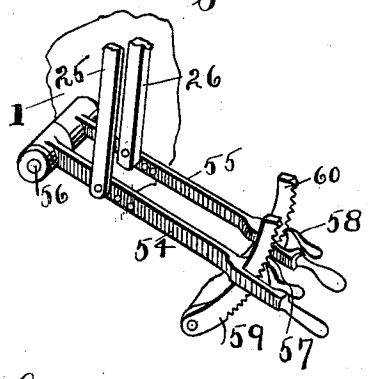
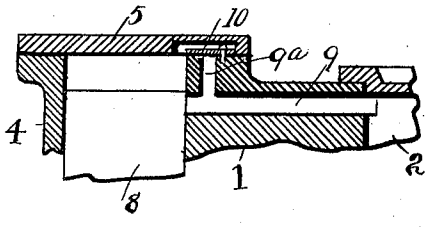



Fig. 5.

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# UNITED STATES PATENT OFFICE.

MELVIN ALBERT YEAKLEY, OF KAMMS, OHIO.

## PNEUMATIC HAMMER.

1,000,568. Specification of Letters Patent. **Patented Aug. 15, 1911.**

Application filed November 4, 1907. Serial No. 400,715.

*To all whom it may concern:*

Be it known that I, MELVIN ALBERT YEAKLEY, a citizen of the United States, residing at Kamms, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Pneumatic Hammers, and do declare that the following is a full, clear, and exact description of the invention, which will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to pneumatic hammers, and the object of the invention is to provide means whereby the operator can get more delicate blows than formerly and to graduate the blows more assuredly to either light or heavy in accordance with the operator's movements of the treadle or levers, thereby also effecting a saving of power when the light blows are being delivered as well as getting other advantages, as will more fully hereinafter appear.

In the accompanying drawings, Figure 1 is a plan view of the hammer on line *x x*, Fig. 2. Fig. 2 is an elevation of the hammer with the valve mechanism and upper part of the main cylinder and piston in vertical section. Fig. 3 is a view of a modification of the valve mechanism at the immediate top of the power cylinder, and Fig. 4 is a detail view of a valve disk belonging to the construction in Fig. 3. Fig. 5 is a sectional elevation of the upper part of the hammer showing the branch air passage 9 and valve 10. Fig. 6 shows a modification of valve operating means.

In the drawings 1 represents the main frame or body of the hammer, embodying various features hereinafter fully described.

2 is the power cylinder or chamber formed in the rear and upper part of body 1. Said cylinder is open at its bottom and closed at its top by cover 3. 4 is the hammer chamber likewise a part of body 1, and which can be in any suitable form in cross section, such as round, square, part round, octagon, or other form, and is open at its bottom and closed at its top by cover 5.

6 is the power or air compressing and reducing piston, which may be fitted with packing to the inside of power cylinder 2 so that it can play freely from end to end of said cylinder for making the air pressure and vacuum.

8 is the hammer proper, which also serves as a piston in its chamber, but is referred to hereinafter merely as hammer for convenience, and is fitted to chamber 4 to work freely inside from end to end.

8ª shows the hammer in dotted lines and as it appears in raised and suspended position, as when running idle, as hereinafter more fully described.

9, Fig. 5 is an air passage, that connects the power chamber with the hammer chamber at their closed ends.

9ª is a branch air passage from passage 9 leading to the extreme top on the inside of hammer chamber.

10, Fig. 5, represents a leather flap valve, in this instance, which closes the air passage from top end of hammer chamber inside to passage 9ª which cushions the hammer on its reverse of the upward movement, but is adapted to admit air from passage 9ª into top of hammer chamber on the downward movement of the hammer.

11 is a support fastened to body 1 for supporting controlling valves 12 and 13, in this instance.

14 is a passage leading from passage 9 to the controlling valves 12 and 13, and of these 12 is the air outlet controlling valve, and 13 is the air inlet controlling valve. These valves control the air between the atmosphere and the interior of the machine for suspending and controlling the hammer, as hereinafter more fully described. Said valves are spring pressed to their seats in any preferred way and have stems 15 and 16, respectively. Both valves seat downward as shown in Fig. 2. Treadle connecting link is adapted to exert a downward pressure on upper valve 12 through an adjustable headed screw member 23 bearing on spring 21 over said valve 12, and treadle link 26 exerts a like pressure on valve 13 through an arm 17 adjustably fixed on the upper end of link 26 and engaged over spring 22 about valve stem 16 of said lower valve 13. Each of said links is attached to treadle 29 by a knuckle 27 and 28, respectively, a suitable distance from its intermediate pivot 31, from which said treadle is suspended on a knuckle 30, rigid on the treadle.

32 is a spiral spring resting on the base 33 of body 1, and pressing upward against the treadle, supports it in its raised position and returns it to that point when relieved from depression. Said spring also acts to compress spring 22 through link 26.

34 is a stop for the treadle on its upward movement, and full lines A show the treadle in raised position, dotted lines B represent it partly depressed, and lower dotted lines C fully depressed, which will be more fully explained hereinafter.

35 is the hammer die, secured to the hammer by key 36 in the usual way, and serves as a part of the hammer.

37 is a die block secured to body 1 by key 38 in the usual way, and 39 is the stationary die secured to die block by key 40 in the usual way also.

49 is a hand lever to lift valve 13 by the end projecting under it and hold it off of its seat, and it is hinged to body 1 by bolt 50 and confined within keeper 51 which limits its movement and is constructed to fix the lever at different elevations therein or thereon to hold valve 13 from its seat, or said valve 13 is held off of its seat by lever 49 when depressed and fixed in its lower position in keeper 51.

Now, referring to the modification, Fig. 3, both valves $12^a$ and $13^a$ are arranged on the cylinder cover or head instead of on support 11, which is not needed in this instance. Valve $13^a$ is inverted from that shown in Fig. 2, and also reverses the action of the treadle connecting rod 26. Otherwise it is the same as in Fig. 2.

Fig. 6 shows a modification of the mechanism for operating valves 12 and 13 having a pair of hand levers 54 and 55 for operating the controlling valves instead of using the treadle. Lever 54 is connected with link 25, and lever 55 with link 26, and both said levers are hinged to or pivoted on body 1 by bolt 56. Pawls 57 and 58 are fastened to said levers, respectively, and engage ratchets 59 and 60 which hold the levers at any point desired. These levers serve to operate the controlling valves 12 and 13 independently of each other, so that any kind of blow can be delivered that is desired within the range of the machine.

The machine is driven in this instance by power delivered to wheel 47 by belt from a drive shaft in the usual way and extending power to crank 43, and piston 6 is connected to said crank by connecting rod 42 which reciprocates it in cylinder 2.

The operation of the machine is as follows: To start the machine, controlling valve 13 should be held off of its seat and open by lever 49, Fig. 2. Then apply the power to wheel 47 and piston 6 will start to reciprocate. As said piston is reciprocated on its down stroke the place above it is filled with air let through the passage controlled by valve 13 from the atmosphere, and on its up stroke the piston drives the air out of cylinder 2 and out through said passage by said valve 13 to the outside atmosphere. Said valve passage is large enough to let the air out and in freely, so as not to make a pressure of any consequence either above or below atmosphere above piston 6 on either its up or down stroke while running with valve 13 open, and when running in this way it consumes but very little power and the power piston 6 is relieved or running idle and hammer 8 remains down. When the piston is started and running at its normal speed and work is about ready to be done, valve 13 is relieved by lever 49 and allowed to seat itself. When the treadle is in raised position, as indicated by A, the controlling valves 12 and 13 are held in position to control the air so that the hammer will rise and remain suspended as shown in dotted lines and represented by $8^a$ Fig. 2. This is accomplished by holding spring 22, Fig. 2, depressed by means of the treadle and intervening parts, so that valve 13 is held to its seat and the outside atmosphere cannot force it from its seat while a vacuum is created by the downward stroke of piston 6. At the same time valve 12 is free from pressure of spring 21, and it has only the weight of the spring itself as pressure downward on it, so that a pressure in the inclosure on the upstroke of piston 6 can only reach a few ounces above atmosphere outside before valve 12 will lift and allow the air to escape, but on the down stroke of piston 6 valve 12 will close and a strong vacuum be created in the interior space. Now, should the valves instantly be put in this position, as when the treadle 29 is up while the hammer is down, the next stroke of piston 6 will create a strong vacuum above hammer 8 and the outside atmosphere pressure on the bottom of the hammer will lift it rapidly to near the top of its chamber. On the next up stroke of the piston 6, the vacuum will not be entirely broken until the greater part of the stroke has been made and when the vacuum is entirely broken the piston pressure upon the air will lift valve 12 and force the air out before the hammer has time to reverse and fall back any material distance, because the next downward stroke of the piston is soon made and the vacuum again made strong enough, so that the outside atmosphere will catch the hammer before it falls an objectionable distance downward. On the next upstroke of piston 6 there is no air to let out except in case a little should leak in past the joints, and the vacuum is not broken until the piston reaches very near the extreme top of its stroke. At the extreme top of the stroke and while the piston is reversing for the downward stroke, the vacuum is entirely broken over the hammer 8, and during the time it is broken so as not to fully support the hammer 8 on the atmosphere, it will drop a trifle but not to be seriously objectionable, and so on each cycle until changed.

This is what I call running idle. When the machine is running in this way it is in readiness to place work under the hammer to deliver blows upon. While treadle 29 is in raised position spring 22 is compressed, and both are sustained in this position by the tension of spring 32, which is amply strong enough for the purpose.

To make the hammer deliver heavy blows the treadle 29 is depressed about half way down its limit of stroke, as indicated by dotted line B. As it is being depressed rods 25 and 26 are moved in the direction indicated by arrows, and spring 21 compressed and spring 22 expanded. While the treadle is at dotted line B inlet controlling valve 13 is relieved from its spring pressure to about eight pounds per square inch of the area of its end exposed to the atmosphere, while the outlet controlling valve 12 has an increased spring pressure about equal to thirty pounds per square inch of area of the end of it exposed to the interior. When treadle 29 is depressed instantly from A to B, as for striking full blows, on the first down stroke of the piston 6 when it is a little ways down, the vacuum gets to about eight pounds per square inch below atmosphere and balances the spring pressure on valve 13 that holds it seated at this pressure, but as the piston 6 goes farther down valve 13 is lifted from its seat and air rushes past it through its passage and continues to inflow until the limit of the down stroke is reached, leaving the vacuum rarefied to eight pounds per square inch lower than the atmosphere. Now, on the beginning of the next up stroke of piston 6 the vacuum is weakened, and about half way up the vacuum is entirely broken, so that the pressure over the hammer is as great as that under it and it begins to lower, and as power piston 6 continues on its up stroke, it produces a necessary pressure above atmosphere on the interior and acts directly on the top area of the hammer 8 and increases its lowering velocity. Then as piston 6 nearly reaches the limit of its up stroke the interior pressure has reached the balancing pressure outlet valve 12, and the hammer 8 is just getting well started downward but has not moved far yet owing to the quickness of this part of the cycle. As the piston completes this up stroke a little air will be forced out past valve 12, so that a greater force cannot be applied to the hammer 8 than is allowed by controlling outlet valve 12, which now lifts at thirty pounds per square inch interior pressure above atmosphere. During a small portion of the next downward stroke of piston 6, the blow is delivered. The greater portion of the lowering of hammer 8 is accomplished during the time the power piston 6 is making the last small portion of the up stroke and the first small part of the down stroke. Near the completion of the down stroke of piston 6 the vacuum is again produced on the interior to its limit by valve 13 to eight pounds pressure below atmosphere, raising hammer 8 rapidly, and as the balance of the down stroke of power piston 6 is being reached a little air will be let in by inlet controlling valve 13 to rarefy the air so as to insure an accurate volume of air on the interior to make the compression to drive the hammer 8 down on the next up stroke as before. The vacuum continues to about half of the next up stroke of piston 6, and during that time the hammer 8 is still rising and is about to be stopped by a cushion of compressed air above it in this way. After hammer 8 passes up by or past passage 9 opening into the side wall of the hammer chamber 4 a little way down from the top, the suction is cut off and the rarefied air and the velocity of the hammer cause it to move violently upward and as it passes up the rarefied air changes to a strong cushion by being confined, which stops the hammer 8 and reverses it, or helps to. On the completion of the up stroke of piston 6 the compression occurs for the down stroke of hammer 8, and should hammer 8 be above passage 9 where it opens into the hammer chamber, the pressure will pass up branch passage $9^a$ and lift flap valve 10 and pass thence into the hammer chamber and act on top of hammer 8 and force it down, as before, and so on. At each revolution of the crank the hammer will deliver a controlled uniform full blow until the position of the treadle is changed. When the treadle is depressed to dotted lines C the hammer ceases striking and remains down and receives a full compression at the top reverse of power piston 6 and reduces the pressure to atmosphere at each lower reverse at each revolution of the crank. This is caused by the spring pressure being forced on valve 12 hard enough so that the interior pressure exposed on its under side cannot lift it to allow air to escape, and the spring pressure is entirely relieved from inlet valve 13 and prevents any vacuum being produced on the suction strokes of piston 6 by allowing the air to lift valve 13 and rush past the same, and thus prevents any lifting to hammer 8. Now, if the treadle is allowed to rise quickly from position C to A, the hammer 8 will rise and remain suspended as before stated. To start the hammer to work, the treadle is depressed a trifle, which forces a slight spring pressure on valve 12 and prevents the air from outletting freely on the compression stroke and makes it act proportionately on the top of hammer 8, and the spring pressure on inlet valve 13 is slightly relieved and admits a little air on the suction stroke of piston 6.

To strike light blows the treadle is depressed a little farther, and the spring pressure increased on valve 12 to hold the air proportionately from outletting on the compression stroke of piston 6, so as to act on the top of hammer in like proportion for driving it down, and to relieve the spring pressure on valve 13 properly in conjunction with the former to let in air enough on the interior on the suction stroke of piston 6 to permit the hammer 8 to lower to strike during the compression stroke of the piston 6. And in like proportion to the depression of the treadle, the blow will increase to the full blows until the treadle reaches position B. As the treadle is depressed beyond B to near C, the blows diminish in force in proportion to the distance the treadle is moved, until they cease entirely when the treadle is near C. These blows are diminished in force because of spring pressure being increased on outlet valve 12, and a greater volume of air is confined inside when the pressure is higher at the time of the full limit of the compression stroke of piston 6, so that when the suction stroke is being completed the vacuum is so rarefied by the inner air that it is not strong enough to allow the atmosphere to lift hammer 8 the full limit of the up stroke, and the blows are diminished by the shortening of the strokes and not the weakening of the pressure. The spring pressure is also weakened proportionately on valve 13, which inlets air on the suction stroke of piston 6 and weakens the vacuum in proportion.

It should be noticed that the range of blows either light or heavy obtainable by the movement of the treadle anywhere in the limit between A and B are of different character than the range of blows either light or heavy obtainable by the movement of the treadle anywhere between B and C, and both kinds are very desirable at different times even on one piece of work when being used for forging.

When the hand levers 54 and 55 are used, Fig. 5, instead of treadle 29, it is obvious that a greater variety of actions can be obtained than with the treadle, although it takes an extra person to operate the hammer when the two levers are used.

Now, referring to modification, Fig. 3, the inlet and outlet valved air passages 12′ and 13′ are located in the cylinder cover 3 instead of being on support 17, which is not needed in this instance. Valves $12^a$ and $13^a$ close the said air passages 12′ and 13′ from opposite directions respectively, the valve $12^a$ being outside and valve $13^a$ inside the cylinder. Valves $12^a$ and $13^a$ are slightly spring pressed to their seats by springs 21′ and 22′ respectively, and are guided by their respective studs 61 and 62. Cutoff valve 12″ is fitted closely to cylinder cover 3, and is held in place and rotatable on stud 61 by any suitable means connecting therewith so as to open, close or control the outward passage of air through passage 12′. Cutoff valve 13″ is fitted closely to cylinder cover 3, is held in place by stud 63 and is rotatable thereon, and is rotated normally by any suitable means connecting therewith so as to open, close, or control the inlet passage of air through passage 13′. Arms 64 and 65 on valves 12″ and 13″ respectively may be connected through any suitable intermediate connections to treadle 29 or to hand levers 54 and 55 respectively by rods 25 and 26. The operation is thus: Assuming that power piston 6 is being reciprocated at its normal speed and valve 12″ is open and valve 13″ closed, as shown in Fig. 3, as the piston rises when first started the air of piston displacement is driven out passage 12′ past valve $12^a$ and when the piston lowers valve $12^a$ checks and prevents any inlet and a strong vacuum is created in the inclosure and raises hammer 8 to the position as shown in Fig. 2 as $8^a$; on the next upstroke the vacuum is maintained until the piston reaches nearly the top limit and suspends hammer 8 in its raised position during the time of the remainder of the upstroke and the reverse and a little ways of the next down stroke there is no vacuum to suspend hammer 8 but the time is so short that the hammer has not time to fall but a trifle, not objectionable, until the vacuum that is created by the continuation of the down stroke catches it again, and so on each cycle of the piston the hammer 8 is suspended in its raised position $8^a$ while the valves are in this position. To make the hammer strike a light blow close valve 12″ partly and open valve 13″ a trifle. The action is thus: On the down stroke of piston 6 some air is let in past valve 13″ and on the upward stroke of piston 6 a pressure is created in the inclosure because of the outlet 12′ being partly closed, and this pressure drives hammer 8 down. On the next down stroke of piston 6 the hammer is again raised, and so on consecutively each cycle until changed. To make the hammer 8 strike hard blows open both valves 12″ and 13″ only a trifle. To make the hammer 8 remain down, close valve 12″ and open wide valve 13″. The opening of valve 13″ prevents any vacuum being created in the inclosure on the downward stroke of piston 6, thereby allowing the hammer 8 to remain down. It is obvious that any sort of a blow or blows required within the range of the hammer can be obtained by the movement of the valves 12″ and 13″. Therefore it is not necessary to describe the action of them any further. It should be noted, however, that there is no obstruction in the air passage 9 that connects the power chamber 2 and hammer

chamber 4 to retard the passage of air either way for any purpose which would cause a loss of power.

In this specification the terms, top, bottom, side, up and down are used for convenience but are only intended to be used as the drawings show the machine herein. The machine will work in any position either reverse of that shown, or in a horizontal position, or the hammer chamber and the power chamber can be at any angle to each other as well as parallel, if preferred.

If preferred, the power cylinder can be in a separate part from the hammer frame and connected therewith by a pipe or other equivalent connection.

A guide piece $6^a$, Fig. 1, for the hammer runs from top to bottom of the hammer chamber and has an inner flat side exposed to the flat side of the hammer, to prevent the hammer from turning in the said chamber.

The details of the invention as shown are fully described herein, but all equivalent parts and constructions may be substituted and not depart from the spirit of the invention.

What I claim is:—

1. In pneumatic hammers, a power chamber closed at one end and a packed piston working therein, a hammer chamber closed at one end and a hammer therein, an air conduit connecting the closed ends of said chambers, an open air passage entering said conduit and an outlet valve in said passage adapted to automatically open by the pressure and close by the suction produced by said piston for relieving the pressure in the air spaces between said hammer and piston.

2. In pneumatic hammers, a power chamber and a hammer chamber closed each at one end and open at the other and connected at their closed ends by an air conduit, and a power piston and a hammer in their respective chambers, an automatically controlled valved outlet and inlet air passage from the air space inclosure between said hammer and power piston, respectively, to the outside atmosphere, and manually operated means for controlling said valves to graduate and control the quantity of air in said inclosure, whereby the action of the hammer is graduated and controlled while said power piston is being reciprocated.

3. In pneumatic hammers, a power chamber and a piston therein, a hammer chamber and a hammer therein, an air conduit connecting said chambers and an air inlet and an outlet passage from said inclosure to the outside atmosphere, an automatic opening and closing valve in each of said passages, said valves opening in their said respective directions and closed in the other, a controlling spring for each of said valves, and manually operating means for compressing and expanding each of said springs for controlling said valves.

In testimony whereof I sign this specification in the presence of two witnesses.

MELVIN ALBERT YEAKLEY.

Witnesses:
E. M. FISHER,
R. B. MOSER.