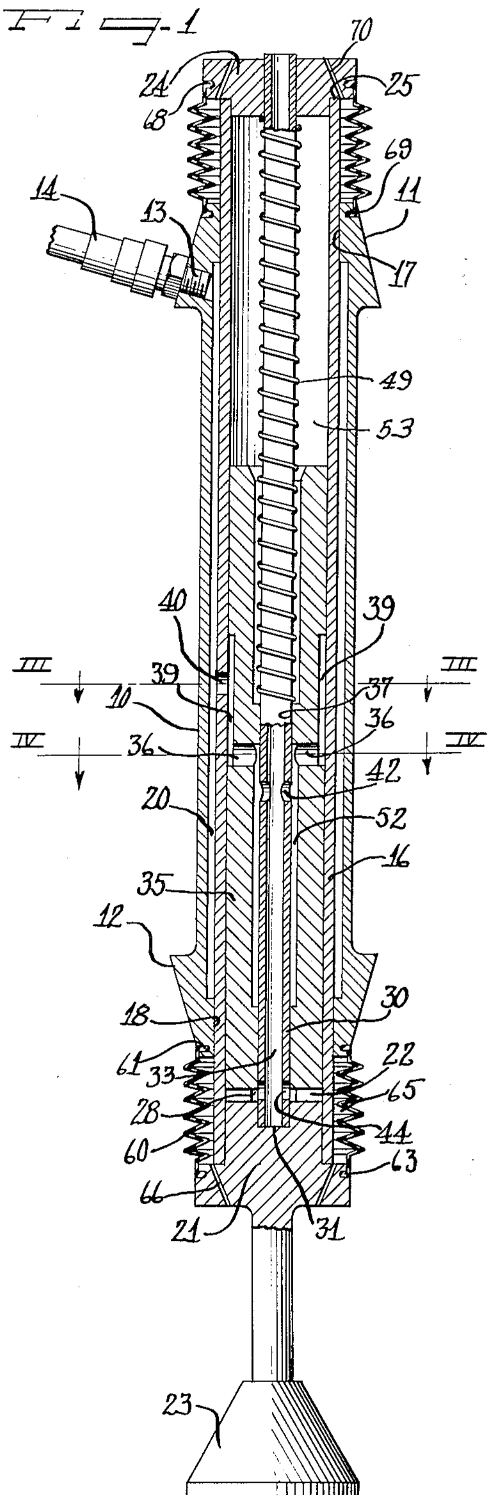
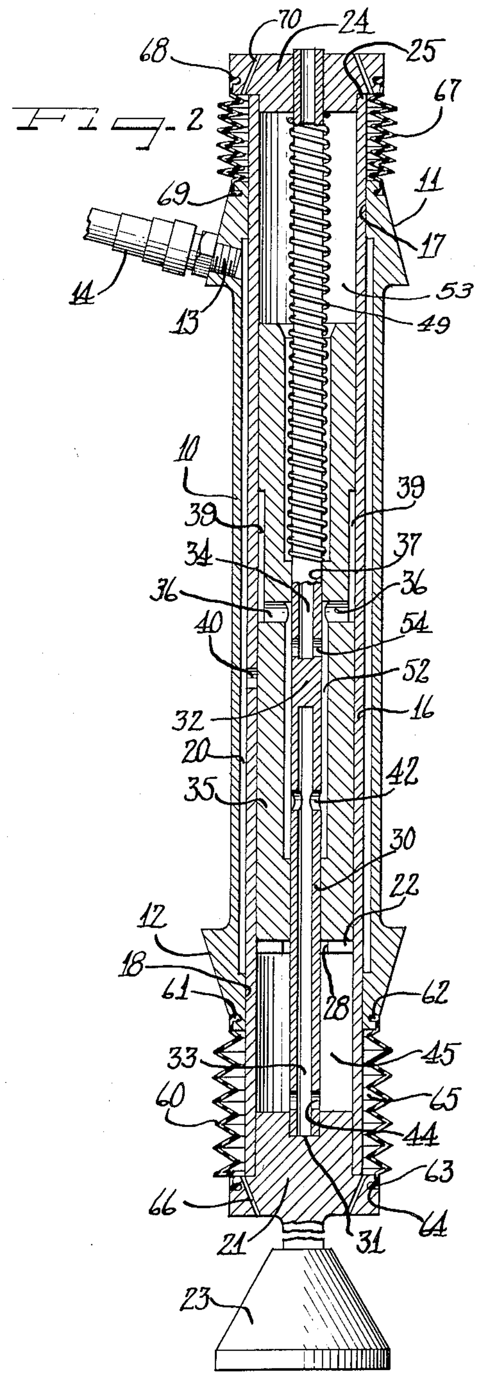
June 5, 1956 S. ALTSCHULER 2,748,750

VIBRATIONLESS PNEUMATIC IMPACT TOOL

Filed Jan. 13, 1953 2 Sheets-Sheet 1





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Filed Jan. 13, 1953 2 Sheets-Sheet 2

Fig-3

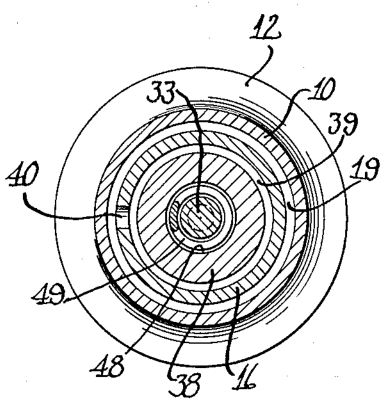


Fig-4

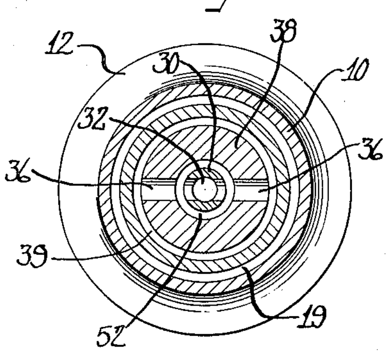
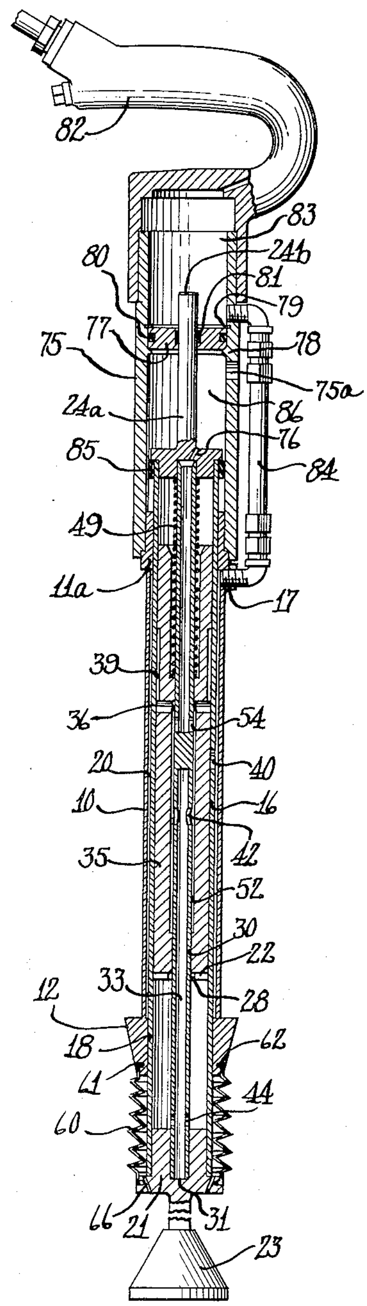


Fig-5



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VIBRATIONLESS PNEUMATIC IMPACT TOOL

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11 Claims. (Cl. 121—25)

The present invention relates to a substantially vibration-free, pneumatically operated tool, such as a sand tamper, rock drill, demolition tool, pile driver or the like.

Among the major defects found in the prior art tools of the type above mentioned, all of which utilize a reciprocating motion, are the large vibrations and force reactions which are imposed upon the operator of the tool. These forces are transmitted to the operator through the casing and handle, and seriously detract from the performance of the tool, both as to accuracy and as to the tiring effect upon the operator.

The nature and extent of the reactions in the prior art tools have been dependent to a large degree on the mass of the tool body, or pneumatic piston cylinder, the mass of the piston and the rate of reciprocation. The effect of these factors in all of the tools of which I am aware, has been a vibration that detracts materially from the operator's efficiency.

The present invention provides a substantially vibration-free pneumatically operated impact tool which overcomes the disadvantages normally associated with pneumatically operated reciprocating tools. Further, the tools constructed according to the present invention are recoilless when operated in a substantially vertically downward position and are subject to only a constant, non-vibrating, recoil force when utilized in a horizontal or inverted position. This is generally accomplished by providing a system in which two masses move in opposition to each other in such a manner that the vectorial sum of their momentums is substantially balanced. Since these masses are in motion, kinetic energy can be abstracted from one or both of them to do the work. A floating handle member is then associated with the two reciprocating masses in a semi-isolated manner so that it retains the masses in their proper paths of motion without receiving any reaction forces from them.

An object of the present invention is, therefore, to provide a balanced system of reciprocating masses, which is supported and controlled by handle means so that the system can be controlled in its direction of application without imparting vibrations to the handle and hence, to the operator.

Another object of the present invention is to provide a substantially vibration-free pneumatically operated tool.

Still another object of the present invention is to provide a pneumatically operated tool which is recoilless when operated in the vertically downward position.

Yet another object of the present invention is to provide a constant recoil, vibration-free reciprocating tool for use in a horizontal or inverted position.

Still another object of the present invention is to provide a pneumatically operated tool including a reciprocating tool element, and an oppositely reciprocating coaxial piston, and a handle for supporting and guiding both the tool element and the piston while at the same time being carried by the tool element so that no shock or vibration is imparted to the handle.

Yet another object of the present invention is to provide a very simple, lightweight reciprocating tool which is capable of great accuracy of operation.

2

Still a further object of the present invention is the provision of a method for applying a substantially constant recoil reaction force to a reciprocating tool used in a horizontal position, without imparting at the same time vibration to the handle operating means.

Still other and further objects will become apparent to those skilled in the art from a consideration of the attached sheets of drawings, which by way of preferred example only illustrate a tamping tool embodying the principles of the present invention.

On the drawings:

Figure 1 is a longitudinal sectional view, of the tamper of the present invention at the start of one cycle of operation;

Figure 2 is a longitudinal section similar to that in Figure 1 and illustrating the position of the parts after its introduction of compressed air to cause opposite reciprocation of the reciprocating masses;

Figure 3 is a cross-sectional view taken substantially along the line III—III of Figure 1;

Figure 4 is a cross-sectional view taken substantially along the line IV—IV of Figure 1; and

Figure 5 is a longitudinal elevation, in partial section, showing a modified form of the tamper of the present invention incorporating a constant force applying recoil chamber.

As shown on the drawings:

As may clearly be seen from Figures 1 and 2, the tamper illustrated in the drawings includes a hollow handle or sleeve **10** having annular flange portions **11** and **12** at the opposite ends thereof. The flange portion **11** is suitably bored to provide an inlet port **13** for the introduction of compressed air or other expanding gas into the assembly through a pipe fitting **14**.

Inside the handle **10** and supported therein for sliding movement relative thereto is a tool assembly. This assembly includes a cylindrical sleeve **16** which is freely slidable within the sleeve **10** in bearing contact with a pair of substantially frictionless bearing surfaces **17** and **18** on the annular flanges **11** and **12**.

In order to provide an annular air supply chamber substantially the length of the handle, the handle **10** is recessed to provide an annular space **20** surrounding the central portion of the sleeve **16** so that the only points of contact in the sleeve **16** and the handle **10** are at the bearing surfaces **17** and **18**.

A tool member **23** is fixedly secured to the sleeve **16** by means of welding or other equivalent fastening processes at the mounting shank **21**.

The opposite end of the sleeve **16** is closed by means of a closure plug **24** having an annular flange surface **25** overlying the sleeve **16**. This plug **24** is likewise secured to the sleeve **16** for movement therewith.

A porting tube **30** is supported on the same axis as the sleeve **16** and the handle **10**, with one of its ends secured within a recess **31** provided in the tool shank **21** and its other end secured to the plug **24** in an air-tight manner. As is shown in Figure 2, the porting tube **30** is substantially hollow except for a central plug portion **32** which provides within the porting tube **30** a pair of longitudinally disposed air passages **33** and **34**.

Mounted for reciprocation between the porting tube **30** and the inner surface of the sleeve **16** is a reactive mass or piston **35**. A plurality of air inlet ports **36** are laterally radially drilled in the piston **35** and serve as passageways for the introduction of air to an annular cavity **52** between the piston **35** and the tube **30**. An annular passage **39** is provided in the piston **35** in connection with the ports **36** and is adapted to cooperate with a plurality of peripherally located apertures **40** in the sleeve

16. Valve ports 42 and 44 are provided at the opposite ends of the passageway 33 for controlling the flow of air through the passageway. A further valve port 54 is provided at the lower end of the passageway 34, and the passageway 34 is vented to atmosphere at its other end.

A reduced bearing portion 37 is provided at the central portion of the piston 35 to provide a bearing surface and also act as an air-tight seal in the valving construction.

In the position of the apparatus as shown in Figure 1, air introduced through the inlet port 13 of the handle 10 can pass through the annular space 20, through the aperture 40 provided in the sleeve 16 and thence to the annular passageway 39. The air under pressure then flows from the passage 39 through the ports 36 into the passage 52, through the ports 42 and the passageway 33 to the ports 44. The air then passes through the ports 44 to the space 45 between the piston 35 and the shank 21. It is noted that with the parts 35 and 21 in the position shown in Figure 1, it is necessary to provide a slot 22 and an annular passageway 28 to permit the air under pressure to be applied over a horizontal surface of the member 35 to effect a lifting action.

The expansion of the compressed air in the chamber 45 forces the piston 35 upwardly against a spring 49 and at the same time forces the tool 23 with its attached tubes 16 and 30 downwardly against the spring 49. In order to aid the spring 49 to arrest the movement of the piston 35, and the plug 24 toward each other, the construction of the present invention utilizes a trapped air chamber 53. This chamber is normally at atmospheric pressure, since it is vented at 54. It will be seen, however, from a comparison of Figures 1 and 2, that as the members 35 and 24 near each other, the surface 37 closes off the vent between the space 53 and passage 34. This traps air in chamber 53 and continued movement of the parts is resisted by the trapped air which acts as a cushion.

After the compressed air has expanded to its maximum volume and inertia forces have carried the parts 24 and 35 to their extreme positions against the force of the spring 49 and the trapped air in chamber 53, the parts are in the position shown in Figure 2. In this position the expanded air is vented to atmospheric pressure in the following manner: The piston 35 has now moved upwardly relative to the valve tube 30 so that the ports 54 and 42 are in connection with each other by means of the annular passageway 52. The compressed air, which is still under substantially higher than atmospheric pressure, is thus vented from the chamber 45 through the ports 44, through the passageway 33, through the ports 42 to the passageway 52 and thence through the passageway 54 and out through the vent passageway 34 to atmosphere. Reciprocation of the parts provides enough inertia effect so that the valve ports 54 will be open to the passageway 52 long enough so that the fluid pressure in the chamber 45 will be reduced substantially to atmospheric pressure at which time the spring 49 and the trapped air in chamber 53 force the member 35 downwardly and the tool 23 upwardly until the parts assume the position shown in Figure 1 in readiness for the repetition of the cycle.

An important feature of the present invention is the adjustment of the mass of the tool assembly which includes the sleeve 16, the shank 21, the tamping head 23, the tube 30 and the plug 24, so that it is substantially equivalent to the mass of the piston 35. By adjusting the masses of these two elements and by forcing them to reciprocate in opposite directions upon the introduction of the compressed air into the chamber 45, both the tool assembly and the piston will move equal distances, but in opposite directions. While it has been found desirable that the masses be equal so that the distances moved are also equal, it should be noted that the equality of mass is not a prerequisite for vibrationless action.

Momentum balance is the critical factor in obtaining such a vibration-free mechanism and it is, therefore, contemplated that different masses can be utilized.

In order to provide a perfectly sealed unit which will not be subject to jamming and other corrosive action occasioned by the materials in the air thrown up by the reciprocating tool. I have provided a bellows-type seal between the handle and the sleeve 16. This bellows comprises an expansible bellows member 60 which is secured by means of a ring-like annulus 61 to a peripheral groove 62 in the annular flange 12 of the handle 10. At its opposite end the bellows is secured by means of the ring-like projection 63 to the annular groove 64 in the shank 21 of the tool 23. The bellows 60 is preferably made of a resilient material such as neolite or rubber which is non-porous and which resists abrasion and corrosion by flying particles. However, it is contemplated that a porous material could be utilized for the bellows 60 so that a filter screen is also provided. When the rubber non-porous bellows 60 is utilized, it is of course, necessary to provide air flow between the chamber 65 and the atmosphere in order to permit free movement between the handle 10 and the tool 23. For this purpose I have shown the peripherally spaced apertures 66 which are small enough to act as individual dual filters. If desired, however, larger apertures may be used with a disc-type filter of conventional design fixed across the openings thereof.

A similar bellows construction is provided at the upper end of the tool. At that end the bellows 67 is secured to the plug 24 and the annular flange 11 by means of the fastening rings 68 and 69 which are substantially identical to those utilized with the bellows 60. Apertures 70 are also provided to permit air to escape from one side of the bellows 67 to the other.

Besides serving the function of a seal for dirt and other foreign matter, the bellows 60 and 67 also act as resilient bumper stops against excessive movement between the handle 10 and the sleeve 16. Should the handle 10 be moved excessively relative to the sleeve 16, the bellows 60 or 67 will be compressed to a point where it is a compact mass of resilient rubber which then acts as a bumper to protect the handle 10 from impact with the members 21 or 24. It should be noted, however, that this bumping feature is not utilized on every stroke of the tamper and it is intended that the handle 10 be positioned by the operator so that the bellows 60 and 67 are never compacted to the point where they act as bumpers continually. The strokes of the piston 35 and the tamper 23 are designed to be shorter than the combined lengths of the bellows 60 and 67, so that the handle may be moved relative to the sleeve 16 during operation to place it in an intermediate position such that there is no impact between the handle 10 and either the member 21 or the plug 24.

In operation, the operator holds the tool in a generally vertically downward direction in order to obtain a vibrationless, recoilless operation. One or both hands are used in grasping the hollow handle 10 and compressed air is then introduced from a suitable source through the fitting 14. This air passes as above described into the annular chamber 20 and then intermittently into the chamber 45 where it expands to reciprocate the piston 35 relative to the member 21 or sleeve 16. Since the movements of the piston 35 and the tamper 23 are simultaneous and in opposite directions, the forces are balanced out and the handle 10 serves merely as a sliding guide for holding the apparatus in an upright position.

Since the handle serves no reaction function, no impulses are imparted through it to the hand of the operator, thereby permitting the handle 10 to remain substantially stationary during operation of the apparatus. It is, of course noted that the handle remains stationary only so long as it is positioned intermediate the maximum stroke positions of the sleeve 16 so that the bellows 60 and 67 do not act as bumpers. Should the bellows act as bumpers, blows will be struck the handle tending to force it into an intermediate position, after which it will remain stationary with no impact forces whatever thereon.

As was explained above, the device thus described provides a vibrationless action in that no vibration reaches the operator through the handle of the mechanism. The apparatus as so far described is also recoilless in that when positioned in an upright manner by the handle 10, the gravitational effect on the tamper 23 and the piston 35 is such as to provide a tamping force in the downward direction. This force, however, is not available when the tamping apparatus is utilized in a horizontal position or in an inverted position, as for example, in the use of a riveter or similar apparatus when driving rivets or nails in walls or overhead structures. In order to overcome this deficiency in the use of the apparatus in other than a substantially vertically downward position, I have provided means for adding a constant recoil reaction force to the system.

As may clearly be seen from Figure 5, I have provided an attachment housing 75 which may be secured to the annular flange 11*a* of the handle 10. The piston and tamper construction is identical to that already described above except that means are provided in the housing 75 for adding a constant force in the direction of intended movement of the tamper 23 to aid or supplant the force of gravity which can be utilized only in the vertically downward position of operation.

In providing such a force applying means, I have extended the plug 24 to include a longitudinally extending projection 24*a* thereon. As shown in the disclosed embodiment, this projection is coaxial with the tube 30 and in order to permit the tube 30 to vent to atmosphere as in the construction shown in Figure 2, a vent 76 is drilled through the projection 24*a* into connection with the recess 34. The projection 24*a* passes through a bulkhead 77 which is carried by the casing 75 and secured axially relative thereto by means of the buttress 78 and the spring retainer 79. A seal 80 is provided between the bulkhead 77 and the casing 75 to prevent the passage of air from one side of the bulkhead to the other. The projection 24 is slidably carried by the bulkhead and seals 81 prevent the leakage of air along the surface of the projection while at the same time insuring a lubricated and, therefore, relatively friction-free bearing surface.

A pistol grip handle 82 of conventional design is provided for supporting the casing 75. The handle 82 encloses a conventional valving arrangement which permits control of air from any conventional source of high pressure air or other expansible fluid. The air, after passing through the valve in the handle 82 enters an accumulator chamber 83 which is located at the top side of the bulkhead 77 as viewed in Figure 5. The air is permitted to escape from the chamber 83 to the anular space 20 between the handle and the sleeve 16 by means of a connecting conduit 84.

It will be appreciated that since the casing 75 completely encloses the plug 24 and the associated end of the sleeve 16, no problem is faced with respect to preventing dirt and other foreign matter from injuring the bearing surface 17 between the handle 10 and the sleeve 16. Therefore, instead of using the bellows 67 utilized in Figures 1 and 2, I have substituted therefor a resilient bumper 85. This bumper serves the same resilient shock absorbing function as that described for the bellows 60 and 67 when in their extreme, compressed position. However, as in the case of the bellows 60 and 67, it is intended that the apparatus be operated by the handle 10 and hence the casing 75, in an intermediate position relative to the stroke of the piston 16 so that neither the bellows 60 nor the bumper 85 are actually normally utilized as bumpers.

In operation, the apparatus shown in Figure 5 operates in a manner substantially identically to the construction shown in Figures 1 and 2. The internal valving of the tamping mechanism is, of course, identical to that already described in connection with the structure in Figures 1 and 2. However, since there is a constant pressure in the accumulator chamber 83, and since the area of the end face 24*b* of the projection 24*a* is constant no matter what the position of the piston, a constant force will be applied tending to force the sleeve 16 away from handle 82 as viewed in Figure 5. This force will either supplement, supplant, or overcome the force of gravity which actuates the tool 23, depending upon the position of the tool, thereby permitting the use of the instrument in positions other than the vertically downward position.

It will further be apparent that in the operation of the construction shown in Figure 5, the air which is exhausted from the chamber 45 during the exhaust stroke, in which the parts are shown in Figure 5, will move through the aperture 44 through the passageway 33, through the port 42 into the annular passageway 52 to the port 54 and from there outwardly along the passageway 34 through the vent 76 into the chamber 86 and out through the aperture 75*a* in the casing 75 to atmosphere. This in effect, therefore, provides exactly the same exhaust route for the gases as provided by the construction shown in Figures 1 and 2 and at the same time permits the addition of a constant biasing force on the sleeve 16 tending to maintain it against the work.

It is to be understood, of course, that the accumulator of the chamber construction herein shown and utilized in connection with the tamper of the present invention could be utilized with other reciprocating tools provided that they utilize the isolated handle construction shown in Figures 1 through 5 of the present invention.

While the present invention is described particularly in connection with a tamping tool, it is evident that the same principles of operation can be employed with suitable modification of the hand gripping portion and tool housing to other types of pneumatically operated reciprocating impact tools such as rock drills and concrete breakers and the like.

It will be understood that modifications and variations may be effected without departing from the scope of the novel concepts of the present invention.

I claim as my invention:

1. A vibrationless pneumatic impact tool comprising an impact member, a reactive mass coaxially aligned with said impact member, a handle member coaxial with said impact member and said reactive mass, said handle having means mounting said mass and said impact member for guided freely slidable movement with respect to each other and said handle and resilient means biasing said mass and impact member against movement away from each other, said last named means being independent of said handle whereby vibrations imposed by said mass and said member are not imposed on said handle.

2. A vibrationless pneumatic impact tool assembly comprising a handle member, an impact tool arranged for reciprocation within said handle member, a reactive mass coaxial with said impact tool and reciprocably mounted within said handle member and means for introducing compressed air to said handle and between said impact tool and said reactive mass to cause simultaneous relative displacement of said impact tool and said reacted mass away from each other and resilient means acting between said impact tool and said mass for urging relative displacement of said impact tool and said reactive mass toward each other.

3. A vibrationless pneumatic impact tool assembly comprising a handle member an impact tool having a tool head and a sleeve secured to said tool head, said impact tool being slidable within said handle member, a piston reciprocal within said sleeve, means for introducing compressed air through said sleeve and between one end of

said piston and said tool head to cause relative displacement of said tool head and said piston in one direction, said piston having means connected therewith to terminate the flow of compressed air to said tool head after a predetermined relative displacement and means for exhausting the compressed air between said sleeve and said piston after said parts have reached said predetermined relative displacement.

4. A vibrationless pneumatic impact tool assembly comprising a hollow handle member, a tool head and a sleeve secured to said tool head, means reciprocably mounting said sleeve within said handle member for free reciprocal movement relative thereto and including means directing air between said handle and said sleeve against substantially equal balancing areas at opposite ends of said handle, a piston reciprocal within said sleeve, means for introducing compressed air between said handle and said sleeve and through said sleeve and between one end of said piston and said tool head to cause relative displacement of said tool head and said piston in one direction, said piston being arranged to terminate the flow of compressed air to said tool head after a predetermined relative displacement of said tool head and said piston, means for exhausting air between said sleeve and said piston after termination of the flow to said tool head, means for terminating movement in said one direction, and means causing relative displacement of said piston and said tool head in the opposite direction upon termination of movement of said piston and said tool head in the said one direction.

5. A vibrationless pneumatic impact tool comprising a handle member, a tool subassembly including a tool head and a sleeve secured to said tool head, said sleeve being reciprocable freely within said handle member, a piston freely reciprocable within said sleeve, a porting tube secured to said sleeve and extending coaxially within said sleeve and said piston, means for introducing compressed air through said handle, sleeve and piston into said porting tube, said porting tube having a port therein for directing the air between one end of said piston and said tool head to cause relative displacement of said tool assembly and said piston in one direction, said piston having valve means arranged to terminate the flow of air through said porting tube after a predetermined relative displacement of said tube and said piston, and means for exhausting air from between said one end of said piston and said tool head after a predetermined relative displacement of said piston and said tool head.

6. A recoilless, vibrationless pneumatic impact tool comprising a hollow handle member, an impact tool assembly including a tool head, a sleeve secured to said tool head and reciprocable within said hollow handle, a piston reciprocable in said sleeve, said piston being disposed within said sleeve to provide spaced air chambers at opposite ends of said piston between said piston ends and said sleeve, means for introducing compressed air into the air chamber disposed between one end of said piston and said tool head to cause relative displacement of said tool assembly and said piston in a first direction, means biasing said piston and said sleeve in the opposite direction, means actuated by the movement of said piston in said first direction for trapping air in the other of said air chambers during the extreme portion of travel of said piston within said sleeve and means for exhausting the air between said piston and said tool head upon a predetermined relative displacement between said piston and said tool head in said first direction.

7. A vibrationless pneumatic tool comprising a movable tool member having a bore, a piston reciprocable within said bore, a handle member slidably guiding said tool member and movable independently thereof, means for biasing said piston in a first direction within said bore and means for injecting compressed air between said tool member and said piston to cause relative motion of said piston in the other direction in said bore, and means for exhausting said compressed air from between said tool member and said piston upon a predetermined relative motion in said second direction.

8. A recoilless tool comprising a handle member having air inlet means therein, a tool housing guided by said handle member and slidable therealong, said tool housing having air inlet means communicating with the air inlet means in said handle member, a piston reciprocable relative to said housing, said piston having air-directing means therein communicating with the air inlet means of said handle member and said tool housing, to direct air between one end of said piston and an end of said housing, venting means in said housing for venting air from said housing during reciprocation of said piston in a first direction and means associated with said housing and arranged to close off the air directing means in said piston during reciprocation of said piston past a predetermined position relative to said housing.

9. A constant recoil, vibrationless pneumatic impact tool assembly comprising a handle member, a reciprocating tool member freely slidable within said handle member, piston means mounted for movement relative to said tool member and biased into contact with one end of said tool member by a spring positioned between said piston and the other end of said tool member, means for introducing compressed gas between one end of said tool member and the corresponding end of said piston for moving said piston relative to said tool member in opposition to said biasing means, valve means associated with said tool member and said piston for terminating flow of said compressed gas and for exhausting the gas between said piston and said tool member upon the movement of said piston relative to said tool member a predetermined distance, and biasing means associated with said compressed air source for providing a constant biasing force against said tool member to move said tool member relative to said handle in a direction opposite to the movement of said piston relative to said tool member.

10. A constant recoil, vibrationless pneumatic impact tool assembly comprising a handle member, a reciprocating tool member freely slidable within said handle member, piston means mounted for movement relative to said tool member and biased into contact with one end of said tool member by a spring positioned between said piston and the other end of said tool member, means for introducing compressed gas between one end of said tool member and the corresponding end of said piston for moving said piston relative to said tool member in opposition to said biasing means, valve means associated with said tool member and said piston for terminating flow of said compressed gas and for exhausting the gas between said piston and said tool member upon the movement of said piston relative to said tool member a predetermined distance, and biasing means for providing a constant biasing force against said tool member to move said tool member relative to said handle in a direction opposite to the movement of said piston relative to said tool member.

11. A constant recoil, vibrationless pneumatic impact tool comprising a handle member mounted for guiding a reciprocating tool element for movement independently thereof into engagement with a work piece, a reciprocating piston slidable within said tool element and biased axially into contact with one end of said tool element by means of a spring positioned between the other end of said tool element and the opposite end of said piston, valve port means in said tool member for alignment with port means in said piston to introduce air from between said handle and said tool element into a space between said one end of said tool element and said piston for moving said piston relative to said tool element in a direction opposite to the direction of said bias, means for disturbing the alignment of said ports upon a predetermined relative movement between said piston and

said tool element to thereby cut off supply of compressed air, and means for exhausting the air between said piston and said tool element upon movement of said piston past said predetermined relative position, and biasing means for placing a constant bias on said tool element relative to said handle in the direction of the work piece.

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