Aug. 28, 1962 A. J. SMITH 3,051,135

PNEUMATIC TOOL

Filed March 27, 1959

3 Sheets-Sheet 1

Fig.1

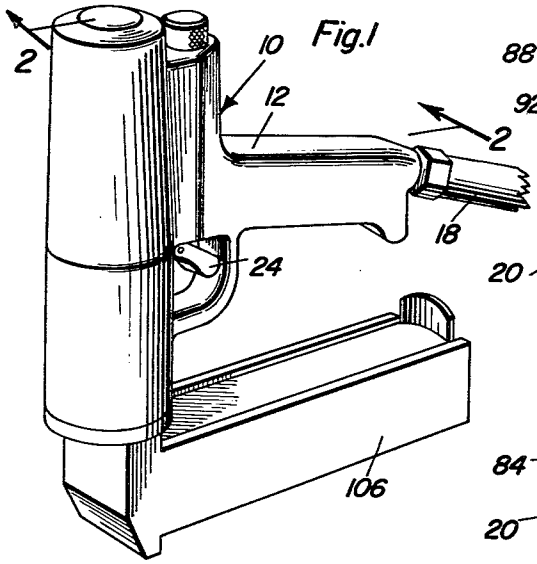


Fig.7

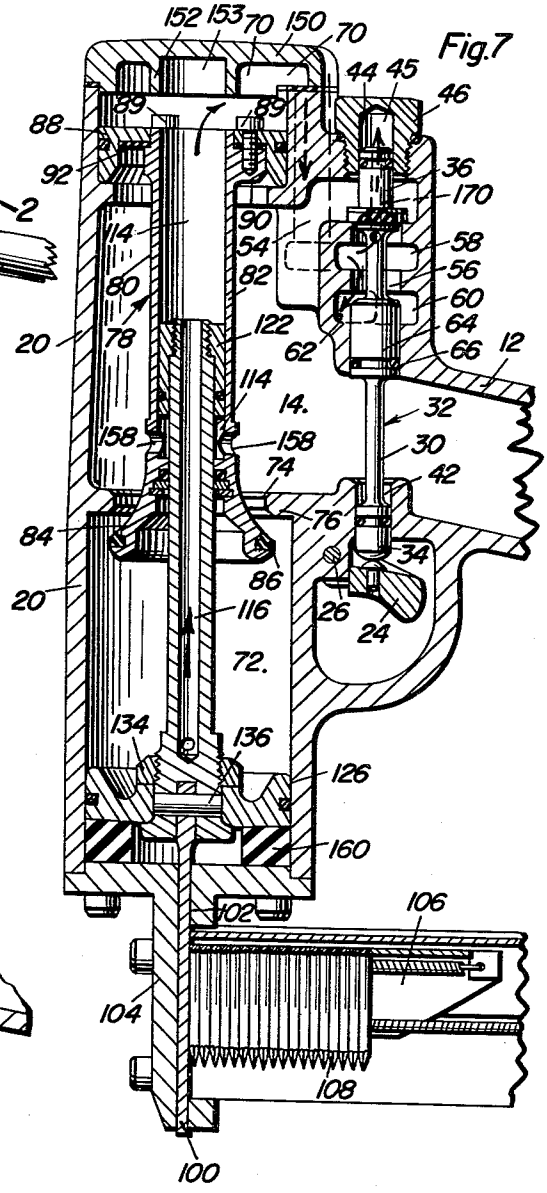
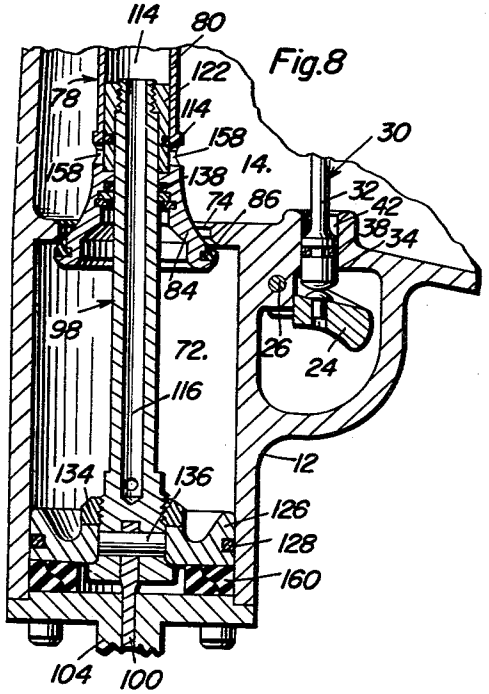


Fig.8



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PNEUMATIC TOOL

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Fig.2

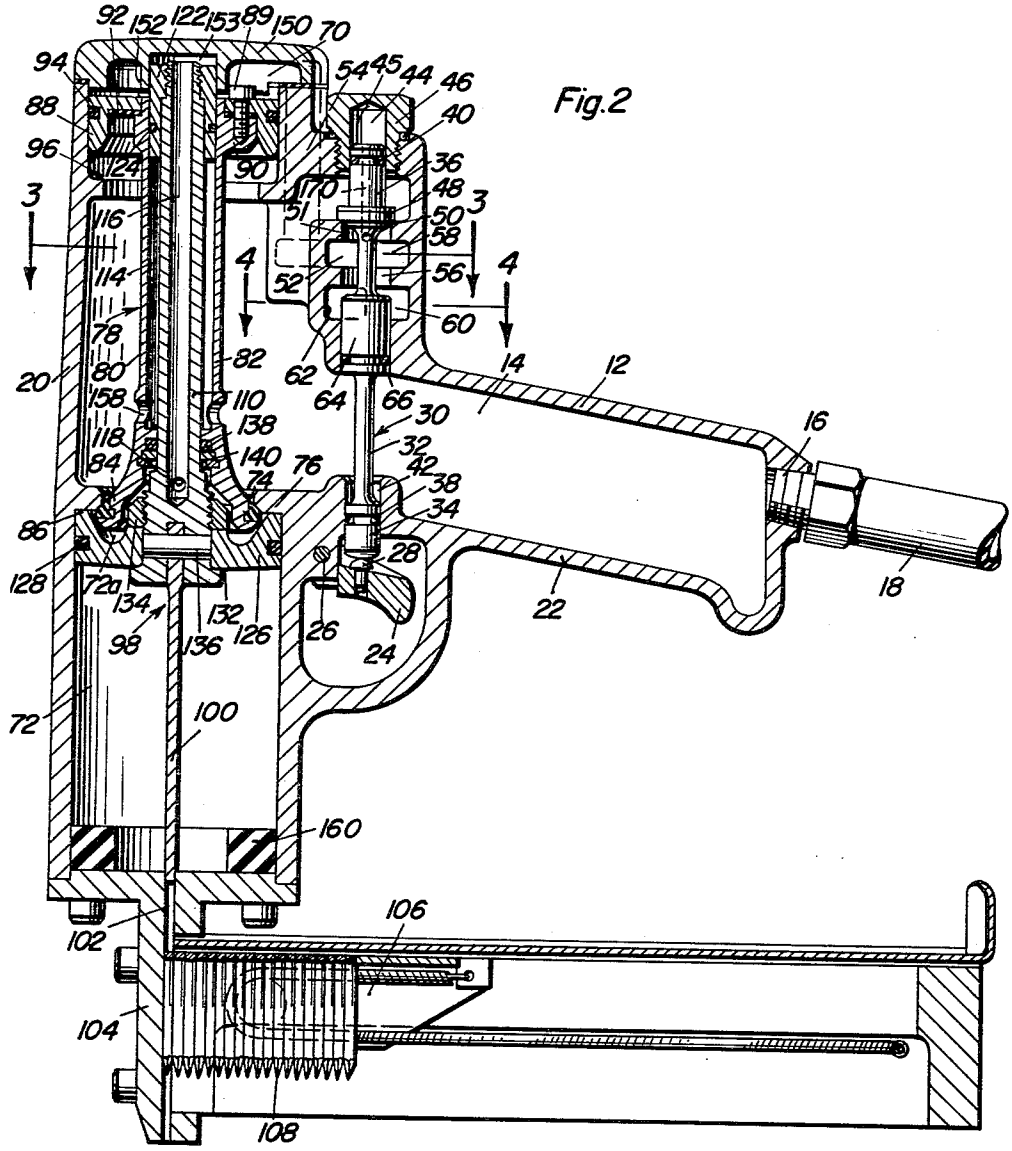
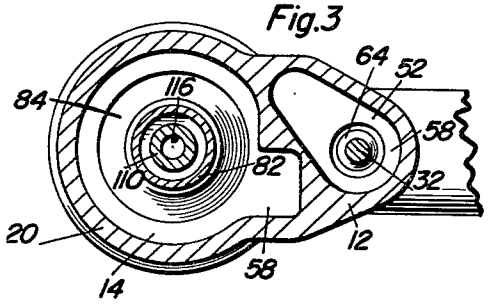


Fig.3



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PNEUMATIC TOOL

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Fig.5

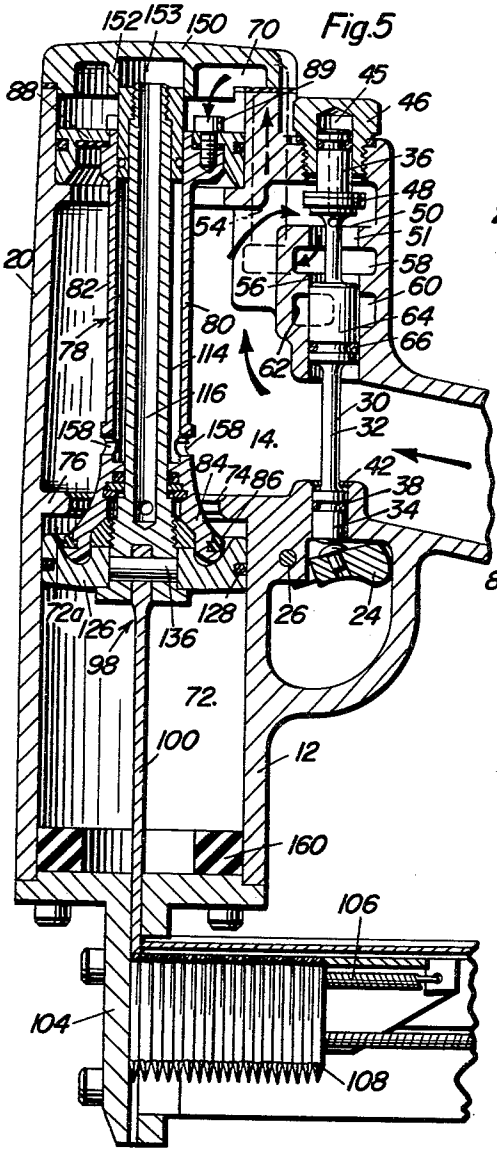


Fig.6

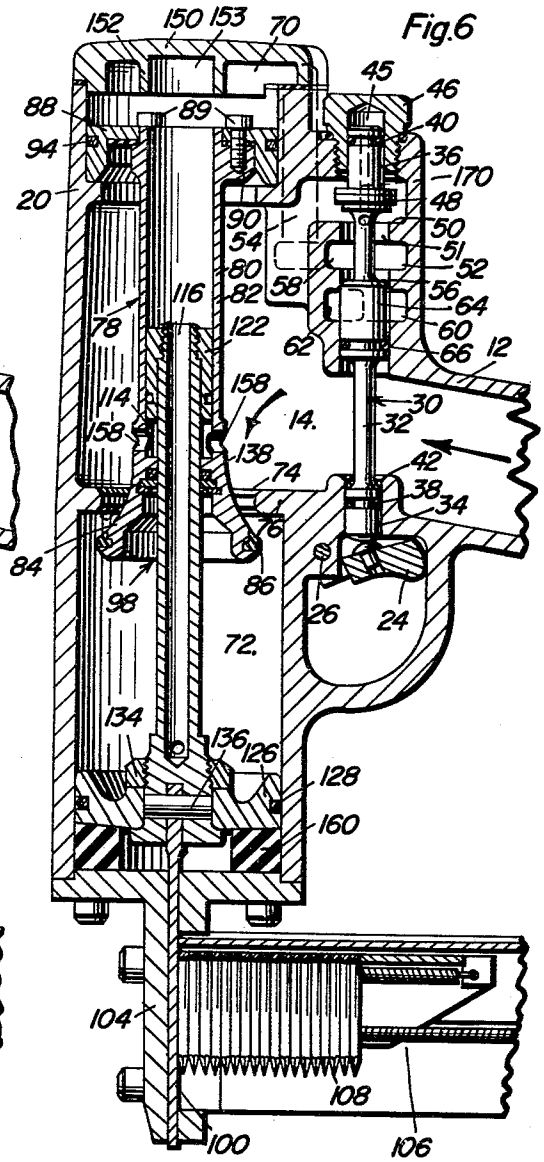
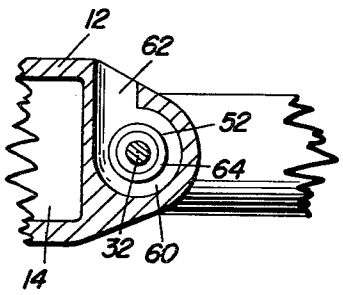


Fig.4



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United States Patent Office 3,051,135 Patented Aug. 28, 1962

3,051,135

PNEUMATIC TOOL

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Filed Mar. 27, 1959, Ser. No. 802,368
16 Claims. (Cl. 121—21)

This invention relates to an impact tool and more particularly to pneumatic impact tools for driving staples, nails or other fasteners.

An object of the invention is to provide a pneumatic impact tool which is light, portable and capable of driving fasteners effectively with a minimum of air pressure.

The pneumatic tool is made as a gun for driving fasteners, although the same principles involved in the operation of the gun-type tool, may be applied to other types of fastener driving equipment. To facilitate the description, the portable tool is selected as a preference with the understanding that the invention is capable of being embodied in various apparatuses.

The portable tool has a hollow body provided with a chamber that is constantly exposed to line pressure, together with a trigger operated valve assembly controlling a network of air conductors. Air under pressure passing through the controlled conductors, is used to actuate a hollow poppet, one of the functions of which is to communicate the pressure chamber with a second chamber occupied by the head of the poppet. As the poppet moves the head becomes unseated from its rest position, opening a port which registers the chambers.

A driver assembly has the larger of a pair of pistons located in the second chamber so that when the poppet is moved to the port opening position a driver assembly commences its stroke. Upon completion of the driving stroke, the driver mechanism is pneumatically returned to the poised position, and the last portion of the return stroke is pneumatically buffered by a unique buffering system built in the tool.

A more specific object of this invention is to provide a pneumatic tool of a general type discussed above wherein there are pneumatic means to return the driver assembly to its poised position in such a manner that it is unnecessary to exhaust the air that has returned the driver assembly to its poised position when the tool is actuated. In other tools of this general class it is necessary to have a complicated venting mechanism that will exhaust this air to the atmosphere at the moment the tool is actuated in order to eliminate the opposing force that the air would offer. In still other tools this air under consideration is not exhausted, but the force that is holding the driver assembly in its poised position reduces the effective driving force on the driver assembly by the same amount.

A further object of the invention is to provide a pneumatic impact tool, again of the same general type discussed above, wherein the effective driving area that the air acts upon in moving the driver assembly forward, is equal to the area of the diameter of the bore in which the driver piston operates. This piston was said to be located in the second chamber, but it is to be emphasized that even though this piston has a stem connected to it, the stem cross-sectional area plus a smaller diameter piston on that stem has air applied under pressure thereon at the same time that air is applied under pressure to the larger piston in the second chamber so that the pressures on both the smaller and larger pistons are additive with the summation being at least equal to the cross-sectional area of the second chamber which has the larger diameter piston located in it. In other tools of this type, the effective driving area of the piston is reduced by the area of the diameter of the driver piston stem, plus the force that is holding the driver assembly in its poised position, if the air is not exhausted before the tool is fired. Again, other tools use a spring to return the driver assembly, and the force acting upon the driver assembly and moving it forward is reduced by the opposition offered by the spring. This invention eliminates all of these parasitic forces to achieve one of the principal objectives of the invention which is to attain maximum thrust on the fastener for a given pneumatic pressure input.

The driver assembly larger diameter piston is limited in its travel by engaging a shock bumper disposed in a second chamber of the tool body. The shock bumper will ordinarily be constructed of rubber or some other elastomeric substance and may possibly deteriorate or otherwise break down. Shock bumpers determining the extent of movement of the driver assembly in a tool of this type, are not new. However, upon failure of shock bumpers in previous tools, serious damage to the driver assembly and other parts of the tool has resulted. An important feature of the invention is the structural arrangement enabling the tool to shut-down automatically upon failure of the shock bumper thereby eliminating expensive repairs that would undoubtedly result if the tool continued to operate after the shock bumper failed.

Most tools of the type under discussion have valve assemblies for controlling the admission of air under pressure into the working chamber of the tool. To my knowledge no substantial efforts have been made to facilitate operation of the valve assembly. A further object of this invention is to provide pneumatic means to reduce the effort that is required to actuate the valve of the valve assembly and to automatically i.e. by pneumatic means, return the valve and the valve assembly to the valve closed position. It is to be understood that the valve of this tool is a multipurpose valve. The closed position is established by having the valve prevent air under pressure from passing into the network of air conductors from the main pressure chamber of the tool, although in this position air under pressure which has served its purpose of actuating the driver assembly, may be exhausted to the atmosphere, through a section of the valve assembly. When the valve assembly is in the open position or what is arbitrarily considered an open position, the valve member seals off the atmospheric port or vent and at the same time admits air under pressure from the main pressure chamber, through the air conductor network to the poppet and driver assemblies of the tool.

A feature of the tool enables the tool to be more smoothly operative by preventing high rates of deceleration of the driver assembly when it is being returned to the poised position. There is a comparatively small diameter cylinder in the tool body which accepts a part of the small diameter piston of the driver assembly. There is a clearance between the small diameter piston and the side wall of the cylinder, this clearance functioning as an orifice to allow bleed air to pass between the surface of the cylinder and the surface of the piston. The stem of the driver assembly is provided with an air conductive passage extending through it and through which the air used for driving the driver assembly is exhausted. During the return stroke of the driver assembly the last mentioned air continues to exhaust through the hollow driver assembly stem, but the rate of exhaust is severely reduced when the small diameter piston enters the cylinder to form a dashpot, or at least, to have the small diameter piston and cylinder function as a dashpot wtih the air compressing in the cylinder and bleeding past the cylinder and piston side walls due to the clearance therebetween. Accordingly, the last portion of the return

motion of the driver assembly is arrested without the accompanying attenuation of shocks. Furthermore, since in the poised position the small diameter cylinder has its face contained within the cylinder, and the initial operation of the tool has air under pressure adjacent to this small diameter piston, this initial actuation air cannot contact the driving face of the small diameter piston. In the structural organization the only parts, aside from the valve assembly and inner surfaces of the tool body, that the air under pressure engages are those of the poppet assembly definitely requiring the poppet assembly to be initially actuated before the driver assembly begins to move. No only does the small diameter cylinder function as a part of a shock attenuating device, but it also assures that the small diameter piston of the driver assembly is protected against receiving air under pressure against its working face until the poppet assembly is properly moved as the initial step in the driving stroke of the tool.

These and other objects, features and advantages will be explanied further in the details of construction and operation that follow:

FIGURE 1 is a perspective view of the tool.

FIGURE 2 is a longitudinal sectional view taken on the line 2—2 of FIGURE 1 showing the driver assembly and poppet in a poised or rest position.

FIGURE 3 is a transverse sectional view taken on the line 3—3 of FIGURE 2.

FIGURE 4 is a sectional view taken on the line 4—4 of FIGURE 2.

FIGURE 5 is a fragmentary sectional view similar to FIGURE 2 but showing pneumatic flow conditions as they exist when the poppet assembly has just opened and the driver assembly is beginning its driving stroke.

FIGURE 6 is a fragmentary sectional view similar to FIGURE 5 but showing an instantaneous position of the driver assembly and poppet as the fastener has been driven from the magazine.

FIGURE 7 is a fragmentary sectional view similar to FIGURE 6 showing the valve assembly which has been pneumatically closed and showing the return flow of the air through the stem of the driver assembly.

FIGURE 8 is a fragmentary sectional view showing failure of the shock bumper at the lower part of this figure.

Pneumatic impact tool **10**, FIGURES 1 and 2, may vary in configuration. The tool has a body **12** provided with a first chamber **14** and an opening **16** registered with the chamber and adapted to connect with a pneumatic pressure source through a pneumatic pressure line **18**. First chamber **14** is composed of a part of the valve **20** of body **12** and handle **22** of the same body when a gun-type configuration is selected. Trigger **24** is freely pivotally mounted on a body carried spindle **26**, and the trigger has a wear pin **28** which contacts one end of valve assembly **30**. The valve assembly consists of a valve stem **32** having heads **34** and **36** of equal diameter at opposite ends thereof. There is an annular groove containing O-rings **38** and **40** in each head **34** and **36** and these together with portions of the heads are operable in bores **42** and **44** in body **12** and hollow plug **46** thereof, respectively. Bores **42** and **44** are coaxial, and bore **44** constitutes part of means to be more fully described subsequently, for returning the valve of valve assembly **30** to the closed position after it is manually opened by actuating trigger **24**. Stem **32** has a valve element **48**, preferably of rubber, and this is disposed on valve seat **50** at one end of valve chamber **52**. The valve chamber is in registry with a network **54** of said conductors formed in body **12**. Port **56** divides chamber **52** into sub-chambers **58** and **60** with the sub-chambers being in registry when the valve assembly is closed (FIGURE 2.) Opening **62**, see FIGURE 4, in body **12** registers with sub-chamber **60** and constitutes a vent to the atmosphere. A cylindrical valve element **64** having O-ring **66** in an annular groove thereof, is attached to stem **32** e.g. by being integral therewith, and is movable with the valve stem **32** to a position at which port **56** is closed (FIGURE 5) when the valve assembly is in the open position, i.e. valve element **48** unseated. It is evident now that the network **54** of air conductors no longer is open to the atmosphere through vent **62**, but sub-chamber **58** becomes registered with the main pressure chamber **14** so that air from the main pressure chamber may pass through the valve assembly, sub-chamber **58**, network **54** and enter a chamber **70** which is subsequently referred to a third chamber.

The internal cavity of hollow body **12** has a second chamber **72** divided from chamber **14** by a port **74**. The port is a central opening in a partition **76** extending across body **12**. Poppet assembly **78** is disposed in part in chamber **14** and in part in chamber **72**. Poppet **80** has a hollow shank **82**. Head **84** provided with annular seal **86** disposed on a seat of port **74** is at the lower end of poppet **80**, and there is a piston **88** at the opposite end of poppet **80**. The piston **88** is bolted as at **89** to a flange **90** on poppet **80**, and there is a gasket **92** between flange **90** and piston **88**. O-ring **94** is carried by a groove in piston **88** and works against the inner surface of chamber **14** above shoulder **96** which protrudes inwardly of the cylinder part of chamber **14** occupied and transversed by piston **88**.

Driver assembly **98** is located in part within hollow poppet and in part within chamber **72**. The driver assembly has a blade **100** operable in passage **102** of nose **104** that is bolted to the lower end of body **12** and which closes the lower end of chamber **72**. Nose **104** has a conventional magazine **106** connected with it for automatically feeding fasteners **108** into passage **102** so that they may be driven by blade **100** in response to operation of the driver assembly **98**.

In addition to blade **100** driver assembly **98** includes hollow stem **110** disposed longitudinally within poppet **80** and spaced from the inner surface thereof to form portions of the side walls of chamber **114**. Since stem **110** is hollow it has a passage **116** extending longitudinally therethrough with the upper end of passage **116** being open and the lower end portion being in registry with a lateral orifice **118**. A comparatively small diameter piston **122** is secured to the upper end of stem **110** and has an O-ring **124** located in an annular groove therein. The piston **122** may be threaded or otherwise secured to stem **110**. A comparatively large diameter piston **126** is fitted on the lower end of stem **110** and located beneath head **84** of poppet assembly **78** and within the bore of body **12** which constitutes the major part of chamber **72**. The piston **126** has an O-ring **128** disposed in an annular groove on the side surface thereof, and there are means for locking piston **126** in place. These means includes lateral flange **132** at the lower extremity of stem **110** which constitutes an abutment for a piston **126**, together with nut **134** threaded on a part of stem **110** and which bears against the upper surface of piston **126**. Blade **100** is fastened to the stem **110** by transverse pin **136** which is locked in place by piston **126** covering the ends thereof. O-ring **138** held in place by retainers **140**, engages the outer surface of stem **110** and is carried by the lower part of poppet **80**.

To facilitate manufacture and assembly there is a cap **150** bolted to a remainder of the body **12**, and the cap has a cavity constituting the end wall and at least a portion of the side wall chamber **70**. Cylinder **152** is fixed to the cap **150** and is coaxial with poppet **80**. The cylinder is slightly larger in diameter than the small diameter piston **122** leaving a clearance between the surfaces of cylinder **152** and piston **122** so that air may may be bled therethrough into chamber **70**. Cylinder **152** and piston **122** serve several purposes which have been described previously. A plurality of ports **158** are formed in the poppet near the lower end thereof, and they communicate

chamber 114 with the chamber 14 at all times. The shock bumper is an annular ring of flexible material, for instance rubber or certain plastics having properties of rubber. Bumper 160 is located at the lower end of the second chamber 72 and is contacted by the lower face of piston 126 during the downward movement of the piston 126, this establishing the end of a driving stroke for the driver assembly 98.

In operation, air under pressure enters chamber 14, and this chamber is continually under line pressure throughout the complete use of the tool. This air surrounds poppet assembly 78 and applies pressure on the enlarged part of valve stem 30 containing valve element 48 sealing it against its seat 50 and thereby prevents air from passing through air conductor network 54. In other words, the valve assembly 30 is pneumatically held in the closed position. O-ring 40 prevents air from entering chamber 45 that was previously mentioned as being constructed in plug 46. Since piston 88 of poppet assembly 78 is larger in diameter than head 84 and its seal 86, the air under pressure in chamber 14 maintains the poppet closed, isolating chambers 14 and 72. Air is free to enter ports 158 of poppet 80 and chamber 114, this air forcing against the lower end of the small diameter piston 122 and holding the driver assembly in an upper position against its stop created by partition 76 and piston 126.

To actuate the tool the operator pulls trigger 24 which removes valve element 48 from seat 50 as the valve assembly begins to open that is, move upwardly with reference to the tool as oriented in the drawings. The effort that is required to pull the trigger and remove valve element 48 from seat 50 is reduced since chamber 45 is free of air pressure. As the valve stem 32 continues to move in the same direction, plunger 64 enters and closes port 56 thereby isolating the sub-chambers 58 and 60 (FIGURE 5). The opening of the valve permits air to pass through port 51 controlled by valve element 48, and air is enabled to flow through sub-chamber 58, network 54 and enter the third chamber 70. As the air continues to enter chamber 70 it is partially restricted from entering fourth chamber 153 defined by the wall of cylinder 152, a part of cap 150 and the working face of the small diameter piston 122, since the air must pass through a narrow clearance between small diameter piston 122 and the bore of cylinder 152. This restricted flow of air entering chamber 153 prevents the air pressure from increasing rapidly in this chamber and moving the driver assembly forward before the rapidly increasing air pressure in chamber 70 moves the poppet assembly 78 forward.

Air under pressure in third chamber 70 reacting on the working face of piston 88, this piston constituting a movable wall of chambers 14 and 70 respectively, moves the poppet assembly 78 forward with the air in chamber 14 passing through port 74 and contacting one of the working faces of the larger diameter piston 126 of driver assembly 98. This begins to move the driver assembly forward, and as this assembly continues to move forward, piston 122 leaves chamber 153 and air under pressure from third chamber 70 is applied to the upper face of the driver assembly piston 122. From this point on (FIGURES 5–7) to the remaining forward travel of the driver assembly, the total effective driving area that the air is acting upon the moving and driver assembly in a forward direction, is equal to the cross-sectional area of the bore which defines chamber 72. The lower end of blade 100 removes a single fastener from magazine 106 and the nose 104 guides the fastener as it is driven into its receiving member until piston 126 contacts shock bumper 160 and completes the driving cycle (FIGURE 7).

As the driving cycle is completed, the air throughout the tool becomes static, and the forces acting upon poppet assembly 78 and tending to move it downward are equal to the forces acting upon poppet assembly tending to move it upward. As the operator releases trigger 24, the air pressure that entered chamber 45 during the driving cycle by way of passage 170 that opens laterally through the valve stem on the valve chamber side of the valve member 48 and that opens into chamber 45, forces the valve assembly toward the closed position. The valve assembly would not move from its open position if chamber 45 were not pressurized in this way, since the forces acting upon the valve assembly 30 and tending to move it in either direction would be equal. Plungers 36 and 34 are of equal diameter thereby having equal pressures thereon so that the air passing through passage 170 and entering chamber 45 is sufficient to pneumatically return the valve of assembly 30 to the closed position.

As the valve assembly continues to move toward the closed position the air in chamber 45 is exhausted through vent 62 by passing through passage 170 and chamber 52. Air under pressure acting upon the surface of the valve assembly containing valve element 48 holds the valve assembly closed and prevents air in chamber 14 from exhausting to the atmosphere. At the same time air in chamber 70 is exhausted through network 54 to the atmosphere by way of the vent 62. As this air is being exhausted from chamber 70, additional air is entering this chamber from chamber 72A which is actually the portion of chamber 72 between piston 126 and port 74. The air in chamber 72A passes through port 118, passage 116 and into chamber 70. Since passage 116 is smaller in diameter than the air conductor of network 54 leading from chamber 70 to the atmosphere, there is a reduction in air pressure in chamber 70 below the air pressure in chamber 14. Therefore, the high pressure in chamber 14 forces poppet assembly 78 upward until port 74 is closed and prevents additional air from entering chamber 72A. The remaining air in chamber 72A is exhausted to the atmosphere and the air pressure in chamber 114 forces the driver assembly 98 rapidly upward by reacting on one face of piston 122. The driver assembly continues to move rapidly until piston 122 begins to enter chamber 153. At this point chamber 153 is formed and partially restricts the further leaving of the chamber and buffers or attenuates the impact of piston 126 contacting its stop.

FIGURE 8 shows the relative positions of the driver assembly 98 and poppet assembly 78 after trigger 24 is released, if the shock bumper 160 is damaged or otherwise fails. The shock bumper 160 allows the driver assembly to continue its movement beyond its normal or predetermined stop position. Piston 88 of the poppet assembly is smaller in diameter than drive piston 126, therefore, when the driver assembly moves forward beyond its predetermined stop position and the trigger is released, the poppet assembly moves upward until lower end of chamber 114 contacts piston 122. The poppet assembly is unable to move upward beyond the position shown in FIGURE 8, since chamber 72 remains pressurized and the force holding the driver assembly forward is greater than the force acting upon the poppet assembly and tending to move it upward. The lower portion of piston 122 functions as a stop to limit the upward travel of the poppet assembly if the shock bumper fails.

The poppet assembly and driver assembly will remain in a lowered position (FIGURE 8) and air will continue to exhaust to the atmosphere through vent 62 until the air supply is disconnected from the tool. The automatic discontinuing of tool actuation in this way prevents damage to other parts of the tool, and only exists when shock bumper 160 fails or becomes damaged from use. The replacement of the damaged shock bumper will restore the tool to its normal condition.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly all suitable modifications and

equivalents may be resorted to, falling within the scope of the invention as claimed.

What is claimed as new is as follows:

1. In a pneumatic impact tool, a body having a first air chamber and an opening in registry therewith for connection with a source of air under pressure, a second chamber in said body, a port separating said chambers, a hollow poppet having a piston at one end operable in said first chamber and forming a movable wall thereof and a head at the opposite end normally closing said port and isolating said chambers, a driver assembly reciprocatable in said hollow poppet, a third chamber in said body with said piston forming a movable wall thereof, a valve assembly carried by said body, an air conductor network controlled by said valve assembly and establishing communication between said first chamber and said third chamber to thereby enable air to enter said third chamber and move said poppet in one direction, said driver assembly including a stem with a smaller piston at one end and operable in said hollow poppet, a larger piston on said stem and disposed in said second chamber and moved by air under pressure passing through said port, a cylinder forming a fourth chamber in said third chamber and accommodating said smaller piston, said smaller piston being withdrawn from said cylinder as said driver assembly begins to move thereby subjecting one side of said smaller piston to pressure from said third chamber, said poppet having a port registered with said first chamber which communicates said first chamber with the opposite side of said smaller piston and thereby returns said driver assembly when said first and second chamber are isolated, during which movement said smaller piston re-enters said cylinder and creates a back pressure to buffer the return movement of said driver assembly.

2. The tool of claim 1 wherein the total effective area of said one side of said smaller piston and said larger piston is at least equal to the cross sectional area of the portion of said second chamber in which said larger piston is operable.

3. In a pneumatic impact tool, a body having a first air chamber and an opening in registry therewith for connection with a source of air under pressure, a second chamber in said body, a port separating said chambers, a hollow poppet having a piston at one end operable in said first chamber and forming a movable wall thereof and a head at the opposite end normally closing said port and isolating said chambers, a driver assembly reciprocatable in said hollow poppet, a third chamber in said body with said piston forming a movable wall thereof, a valve assembly carried by said body, an air conductor network controlled by said valve assembly and establishing communication between said first chamber and said third chamber to thereby enable air to enter said third chamber and move said poppet in one direction, said driver assembly including a stem with a smaller piston at one end and operable in said hollow poppet, a larger piston on said stem and disposed in said second chamber and moved by air under pressure passing through said port, a cylinder forming a fourth chamber in said third chamber and accommodating said smaller piston, said smaller piston being withdrawn from said cylinder as said driver assembly begins to move thereby subjecting one side of said smaller piston to pressure from said third chamber, said poppet having a port registered with said first chamber to communicate said first chamber with the opposite side of said smaller piston, said stem having an air return passageway extending longitudinally thereof and through which the air which has driven said driver assembly is returned for exhausting through a portion of said network controlled by said valve assembly.

4. In a pneumatic impact tool, a body having a first air chamber and an opening in registry therewith for connection with a source of air under pressure, a second chamber in said body, a port separating said chambers, a hollow poppet having a piston at one end operable in said first chamber and forming a movable wall thereof and a head at the opposite end normally closing said port and isolating said chambers, a driver assembly reciprocatable in said hollow poppet, a third chamber in said body with said piston forming a movable wall thereof, a valve assembly carried by said body, an air conductor network controlled by said valve assembly and establishing communication between said first chamber and said third chamber to thereby enable air to enter said third chamber and move said poppet in one direction, said driver assembly including a stem with a smaller piston at one end and operable in said hollow poppet, a larger piston on said stem and disposed in said second chamber and moved by air under pressure passing through said port, said poppet having a port in registry with said first chamber to admit air into said hollow poppet on one side of said smaller piston and return said driver assembly, a resilient cushion in said body and engaged by said larger piston to establish a predetermined end of a driving stroke of said driver assembly so that if said driver assembly over-travels said predetermined end of the driving stroke said smaller piston also overtravels and forms a stop for the poppet assembly and preventing it from commencing its return with the consequence that said second chamber remains pressurized and said driver assembly remains in a non-returned position.

5. In a fastener driving tool, a body provided with a first chamber, a second chamber, said tool body having a port between said chambers, a poppet assembly having a poppet with a head closing said port and isolating said chambers when said poppet assembly is in a position corresponding to the poised position of the tool, a driver assembly including a stem, said poppet being hollow with said stem located therein and movable with reference to said poppet, said stem having means by which to couple a driver element thereto, a piston constituting part of said poppet assembly and located in said first chamber and constituting a movable wall of a third chamber in said body, a valve assembly carried by said body to admit air from said first chamber to said third chamber and thereby move said poppet assembly in a direction to open said port, said driver assembly having a larger diameter piston located in said second chamber, the last mentioned piston being movable by air under pressure entering said second chamber from said first chamber when said port is opened and thereby propelling said driver assembly, and pneumatic means including a smaller diameter piston attached to said stem and located in said hollow poppet for returning said driver assembly, a pneumatic buffer operatively associated with said smaller diameter piston for attenuating the return motion of said driver assembly, said pneumatic buffer including a cylinder within which said smaller diameter piston is received at the end of the return stroke of said driver assembly, said cylinder and smaller diameter piston having clearance therebetween to allow leakage of air under pressure, said stem having a longitudinal passageway registering the lower end of said stem with the portion of said second chamber traversed by said larger diameter piston when said driver assembly is in its driving stroke so that upon return movement of said driver assembly the air previously used for propulsion of said driver assembly is exhausted through said passageway of said stem and said third chamber.

6. In a fastener driving tool, a body provided with a first chamber, a second chamber, said tool body having a port between said chambers, a poppet assembly having a poppet with a head closing said port and isolating said chambers when said poppet assembly is in a position corresponding to the poised position of the tool, a driver assembly including a stem, said poppet being hollow with said stem located therein and movable with reference to said poppet, said stem having means by which to couple a

driver element thereto, a piston constituting part of said poppet assembly and located in said first chamber and constituting a movable wall of a third chamber in said body, a valve assembly carried by said body to admit air from said first chamber to said third chamber and thereby move said poppet assembly in a direction to open said port, said driver assembly having a larger diameter piston located in said second chamber, the last mentioned piston being movable by air under pressure entering said second chamber from said first chamber when said port is opened and thereby propelling said driver assembly, and pneumatic means including a smaller diameter piston attached to said stem and located in said hollow poppet for returning said driver assembly, a pneumatic buffer operatively associated with said smaller diameter piston for attenuating the return motion of said driver assembly, said pneumatic buffer including a cylinder within which said smaller diameter piston is received at the end of the return stroke of said driver assembly, said cylinder and smaller diameter piston having clearance therebetween to allow leakage of air under pressure, said stem having a longitudinal passageway registering the lower end of said stem with the portion of said second chamber traversed by said larger diameter piston when said driver assembly is in its driving stroke so that upon return movement of said driver assembly the air previously used for propulsion of said driver assembly is exhausted through said passageway of said stem and said third chamber, said smaller diameter piston being movable from said cylinder as said stem begins its driving stroke with said driver assembly and thereby becoming exposed to the pressure in said third chamber so that the total force applied to the driver assembly is attained from the summation of pressures on said larger diameter piston and smaller diameter pistons.

7. In a fastener driving tool, a body provided with a first chamber, a second chamber, said tool body having a port between said chambers, a poppet assembly having a poppet with a head closing said port and isolating said chambers when said poppet assembly is in a position corresponding to the poised position of the tool, a driver assembly including a stem, said poppet being hollow with said stem located therein and movable with reference to said poppet, said stem having means by which to couple a driver element thereto, a piston constituting part of said poppet assembly and located in said first chamber and constituting a movable wall of a third chamber in said body, a valve assembly carried by said body to admit air from said first chamber to said third chamber and thereby move said poppet assembly in a direction to open said port, said driver assembly having a larger diameter piston located in said second chamber, the last mentioned piston being movable by air under pressure entering said second chamber from said first chamber when said port is opened and thereby propelling said driver assembly, and pneumatic means including a smaller diameter piston attached to said stem and located in said hollow poppet for returning said driver assembly, a pneumatic buffer operatively associated with said smaller diameter piston for attenuating the return motion of said driver assembly, said poppet having a port in registry with said first chamber and in registry with the space between the inner surface of said poppet and the outer surface of said stem so that air entering said space reacts on a face of said smaller diameter piston to return said driver assembly after the pressure in said first chamber has returned said poppet to the position at which said poppet closes the first mentioned port and thereby prevents pressure of said first chamber from further reacting on said larger diameter piston.

8. The tool of claim 7 wherein there is a shock bumper in said second chamber against which said larger diameter piston contacts to establish the limit of travel of said driver assembly in one direction, said shock bumper being flexible.

9. The tool of claim 7 wherein there is a shock bumper in said second chamber against which said larger diameter piston contacts to establish the limit of travel of said driver assembly in one direction, said shock bumper being flexible, and means operable when said bumper is flexed beyond a predetermined limit enabling overtravel of said driver assembly for discontinuing operation of the driver assembly.

10. In a pneumatic impact tool, a body having a first air chamber and an opening communicating therewith for connection with a source of air under pressure, a second chamber in said body axially alined with the first chamber, a port separating said chambers, a reciprocable poppet comprising a hollow stem having a piston at one end operable in said first chamber and forming a movable wall thereof and a head at the opposite end operable in the second chamber to normally close said port and isolate said chamber, said piston being subject to the pressure in the first chamber at all times, a driver assembly reciprocable in said hollow poppet stem, a valve assembly carried by said body, an air conductor network controlled by said valve assembly for establishing communication between said first chamber and the upper side of said poppet piston to thereby enable pressure air to move said poppet in one direction and open said port, the upper side of said piston having a greater effective area than the underside thereof, said driver assembly including a stem with a small piston at one end and operable in said hollow poppet stem, a larger piston on said driver assembly stem disposed in said second chamber and moved in one direction by air under pressure passing through said port from said first chamber, said poppet stem having an opening in constant communication with said first chamber to admit pressure air into said hollow poppet stem on the driver assembly stem side of said small piston for moving said driver assembly in the opposite direction upon the closing of said port.

11. In a pneumatic impact tool a body having a first air chamber and an opening communicating therewith for connection with a source of air under pressure, a second chamber in said body axially aligned with the first chamber, a port separating said chambers, a poppet comprising a hollow stem open from end-to-end and having a piston at one end operable in said first chamber and forming a movable wall thereof, a head at the opposite end of said poppet stem normally closing said port from the second chamber side thereof to isolate said chambers from each other, said piston being subject to air pressure in said first chamber at all times, a driver assembly reciprocable in said hollow poppet stem, a valve assembly carried by said body, an air conductor network controlled by said valve assembly for establishing communication between said first chamber and the upper side of said piston to enable air pressure to move said piston and poppet stem in one direction against the pressure in the first cylinder to open said port, means for limiting the port opening movement of said poppet, said driver assembly including a stem with a small piston at one end and operable in said hollow poppet stem, a larger piston on said driver assembly stem disposed in said second chamber and moved in said one direction from an initial position by air under pressure passing through said port, said poppet stem having a side wall opening in constant communication with the first chamber to admit air pressure into said hollow poppet stem on the driver stem side of said smaller piston for returning said driver assembly to its initial position when said port is closed.

12. In a fastener driving tool, a body provided with a first chamber, means for supplying air under pressure to said first chamber, a second chamber axially alined with the first chamber, said tool body having a port between said chambers, a poppet assembly comprising a stem having a head at one end for closing said port from the second chamber side thereof and isolating said chambers, said stem extending from said head into said first chamber, a driver assembly in said second chamber and including a stem, said poppet stem being hollow and forming an open

ended cylinder with said driver assembly stem located therein and movable with reference to said poppet assembly, said driver assembly stem having means by which to couple a driver element thereto, a piston constituting a part of said poppet assembly stem and located in said first chamber to provide a movable wall of a third chamber in said body, said poppet assembly being normally urged to the port closing position by the air pressure in said first chamber acting on said poppet piston, a normally closed valve assembly carried by said body and adapted when opened to admit air from said first chamber to said third chamber and thereby move said poppet assembly in a direction to open said port, the third chamber side of said piston being of greater effective area than the first chamber side of the piston, means for limiting the port opening movement of said poppet, said driver assembly having a large piston located in said second chamber, the last mentioned piston being axially movable relative to said poppet assembly by air under pressure entering said second chamber from the first chamber when said port is opened for propelling said driver assembly in one direction from an initial position, and pneumatic means including a smaller piston attached to said driver assembly stem and located in said poppet stem cylinder for returning said driver assembly to its initial position when said port is closed.

13. The combination of claim 10 including buffer means in said second chamber cooperating with said larger piston to cushion the driving stroke of said driver assembly, and means operable upon excessive movement of said larger piston on said driving stroke to unseat said poppet head and prevent further operation of said driver assembly.

14. In an impact tool having a pair of axially aligned first and second cylinders and including a port for separating said cylinders and means for maintaining the first cylinder in continuous communication with a pneumatic pressure source, a combination valving and driving unit for operation within said cylinders comprising a poppet having a hollow stem and a driver having a stem slidable coaxially in the hollow stem of the poppet, said poppet stem having a head at one end adapted to close said port from the second cylinder side thereof and a piston at its opposite end pneumatically operable in the first cylinder, said driver assembly having a large piston at one end of its stem for pneumatic operation in said second cylinder and a smaller piston at the other end of its stem slidably fitted in the hollow stem of said poppet, said hollow poppet stem having a side wall opening adjacent said head for continuous communication of pneumatic pressure in said first cylinder with the interior of the poppet stem and said smaller piston, and means within said poppet stem for sealing the driver stem against leakage of pneumatic pressure therealong from said side wall opening to said second chamber.

15. The valving and driving unit defined in claim 14 wherein the driver stem has a longitudinal passage extending from its small piston end to a lateral opening adjacent said large piston.

16. The valving and driving unit defined in claim 14 wherein said hollow poppet stem is provided with internal stop means to engage said smaller piston and limit the coaxial sliding movement of said driver stem relative to said poppet stem under the influence of said large piston.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,051,135

August 28, 1962

Arthur J. Smith

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 2, line 69, for "wtih" read -- with --; column 3, line 13, for "No" read -- Not --; line 69, for "said conductors" read -- air conductors --; column 5, lines 61 and 62, for "FIGURES" read -- FIGURE --; column 6, line 49, for "drive" read -- driver --; line 69, for "the tool to" read -- to the tool to --.

Signed and sealed this 8th day of January 1963.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents