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PNEUMATIC GUN FOR CORRUGATED NAILS AND THE LIKE

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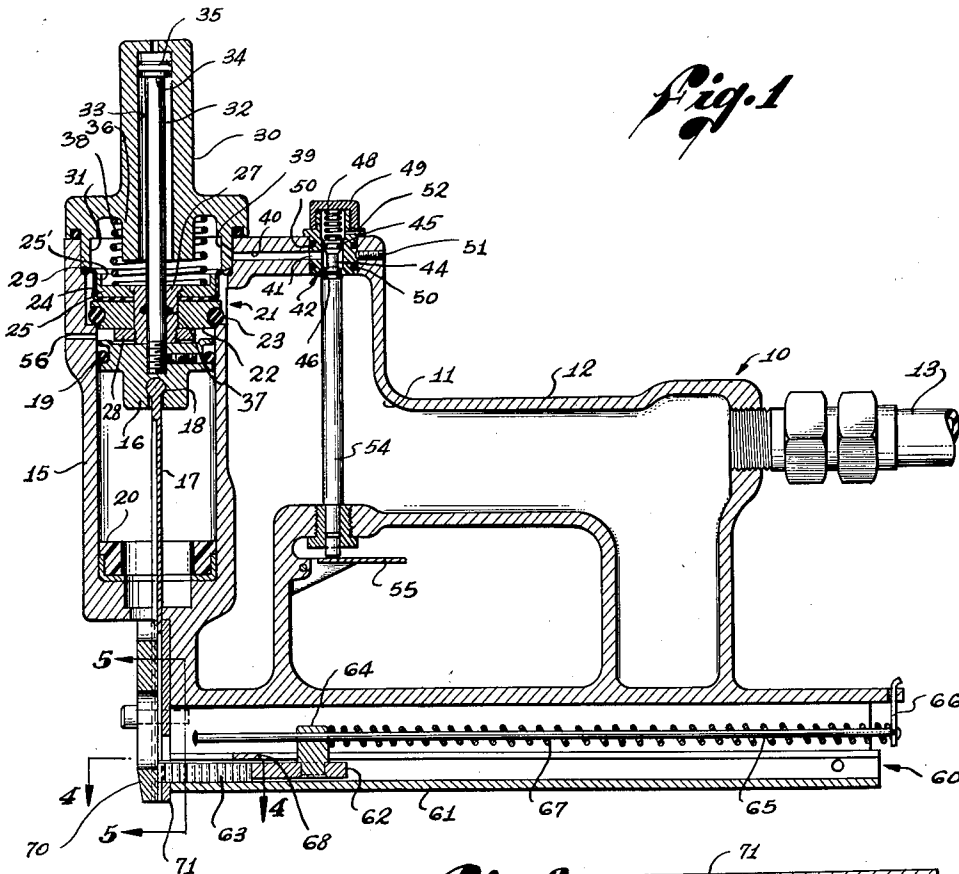
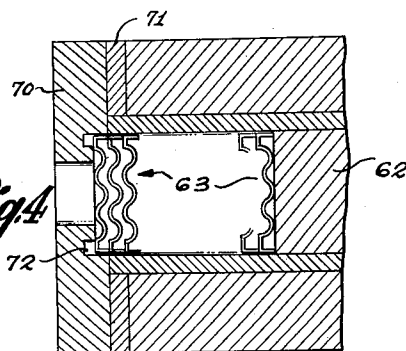
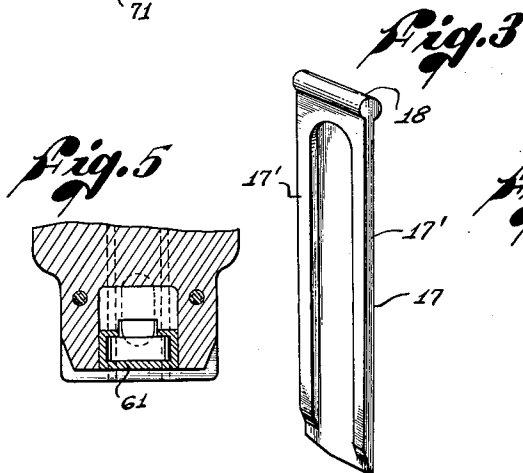


Fig. 1



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PNEUMATIC GUN FOR CORRUGATED NAILS AND THE LIKE

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This invention relates to pneumatic devices, and more particularly to a unique air gun mechanism for driving corrugated nails.

As is well known, pneumatic nail guns have been developed for feeding and driving U-shaped nails or staples. In the typical air gun, a driving piston is adapted for movement along the axis of a cylinder. The piston carries a hammer blade, which is adapted to be moved past the opening of a magazine containing a row of staples, and to cause the end staple to be separated from the remaining staples and be driven into a structure. In one position of the piston, the hammer blade is retracted from the opening of the magazine, to permit the row of staples to be urged to a position wherein the end staple is directly below the hammer blade.

Air guns of the prior art effect movement of the driving piston between its limits by a rather complex arrangement and operation of valves. For example, it is not uncommon to provide an accumulation chamber adjacent the cylinder, and to build up a predetermined amount of air at a given pressure for actuating the piston. A trigger is provided to initiate the accumulation phase, at the end of which the air is directed to the upper portion of the piston to force it downwardly. The blade is thus caused to eject the staple that is in its path. Return of the piston is effected by means of a valve for bleeding the high pressure air above it to the atmosphere, and by directing air under pressure against the lower surface of the piston.

Such structures as above described have several disadvantages. The elaborate valve system necessarily involves considerable time, effort and expense in producing the air gun. Further, and despite the care in production, such a gun often does not operate as quickly and efficiently as desired to return the piston to its initial position after a nailing operation.

In addition, no satisfactory air gun has previously been developed for corrugated nails. Such nails are generally serpentine elements that are nested in rows. A serpentine blade is unacceptable because such a structure, which must be made of hardened tool steel, is extremely difficult to form, and therefore expensive. And occasional breaking of such an expensive item means an undesirably high upkeep expense for the user.

It is an object of our invention to provide a unique air gun that overcomes the above and other disadvantages of the prior art.

It is another object of our invention to provide a unique air gun for manipulating corrugated nails.

A further object of our invention is to provide an air gun for corrugated nails and the like which eliminates the complex arrangement of valves heretofore required for operating the driving piston in the required manner.

A still further object of our invention is to provide a unique air hammer having a minimum number of component parts of simple design and rugged construction which is characterized by economy and ease of assembly and disassembly.

The above and other objects and advantages of our invention will become apparent from the following description taken in conjunction with the accompany drawings of an illustrative embodiment thereof, in which:

FIGURE 1 is a side elevation view in section of an air gun for actuating corrugated nails in accordance with our invention, showing the driving piston that carries the

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hammer blade to be slidably mounted in a cylinder, wherein the piston is provided with a shaft extension into a cap that overlays the cylinder at one end, showing a poppet having a bellows-like diaphragm secured by the cap, such poppet being adapted in a lowermost position to close off the cylinder against high pressure air, and also being adapted to be raised to permit high pressure air to engage the top of the piston and drive it downwardly, and showing trigger means for controlling airflow into the cap in such a manner as to control the operation of the driving piston;

FIGURE 2 is a partial sectional view, similar to FIGURE 1, showing the parts in their relative positions upon actuating the trigger, showing the stem attached to the trigger in a position wherein high pressure air in the cap above the diaphragm is vented to the atmosphere to permit the high pressure air surrounding the poppet to force it upwardly, and showing the piston in its lowermost position to which it is driven by the high pressure air entering the cylinder upon the poppet being raised;

FIGURE 3 is a perspective view of the hammer blade of our invention, showing how the thin nail-driving blade portion is formed from a thicker element so as to provide stiffening ribs;

FIGURE 4 is a sectional view taken along the line 4—4 of FIGURE 1, showing the non-nesting arrangement of the corrugated nails, and showing the nails positioned by the pusher block in the magazine to a point wherein the outermost nail is located in the channel through which the hammer blade passes;

FIGURE 5 is a fragmentary sectional view taken along the line 5—5 of FIGURE 1, showing the guide plate having an opening therein through which to permit the contents of the magazine adjacent thereto to be viewed; and

FIGURE 6 is a fragmentary side elevation view of a corrugated nail in the position under the blade in which it first engages structures to be fastened together.

Referring to FIGURE 1, an air gun in accordance with our invention has a housing 10 that is substantially hollow so as to provide an enlarged air cavity 11 therein. The housing 10 has an elongated handle portion 12, the end of which is adapted to receive an air hose connection 13 for connecting the interior of the housing to a source of high pressure air.

At the end of the housing 10 opposite the air hose connection 13 is a cylinder 15 in which a piston 16 is mounted for sliding movement. The piston 16 carries a hammer blade 17, which at its upper end has an enlarged head 18 adapted to fit slidably in a transverse keyway in the piston 16. The lower end of the blade 17 extends to the exterior of the cylinder 15. As shown, an O-ring 19 in a groove in the piston 16 sealingly engages the inner wall of the cylinder 15.

Normally, the piston 16 is held in an uppermost position in which the lower end of the blade 17 extends just below the lower end of the cylinder 15. The piston 16 is driven to the lower end of the cylinder 15 to cause the blade 17 to drive an object placed in its path. Following such operation, the piston 16 and blade 17 are automatically raised to their uppermost positions. A cushion 20, e.g., a plastic ring, is provided in the lower end of the cylinder 15 for preventing the piston 16 from striking the end of the cylinder and damaging the parts.

To establish the desired operation of the piston 16, we provide a poppet valve 21 that includes a lower ring 22 that carries a peripheral O-ring 23 of such a size that it closes off the upper end of the cylinder 15 in the lowermost position of the poppet 21. A bellows-like diaphragm 24 is clamped between the ring 22 and an upper ring 25. To effectively clamp the diaphragm 24 between the rings 22, 25, we provide a threaded insert or bushing 27 centrally

of the rings and the diaphragm, such insert 27 being shaped like a hollow bolt having a head that fits in a recess in the ring 25, and a threaded portion that extends below the ring 22. A nut 28 is tightened onto the end of such bolt, thereby securing the diaphragm 24 between the rings 22, 25 in the desired manner.

As shown, the ring 25 is provided with an axial skirt 25', and the diaphragm 24 is provided with a portion surrounding the skirt 25' that terminates in a radial flange. The diaphragm 24 has its flange disposed on a radial shoulder 29 that is provided in the housing 10 above the disk 25, such shoulder 29 being coaxial with the cylinder 15. Cap member 30 is provided that has an inwardly extending boss 31 engaging the upper portion of the flange of the diaphragm 24. The cap 30 is secured to the housing 10, as by bolts (not shown), so that the boss 31 clamps the flange of the diaphragm in place.

As shown, the skirt 25' of the disk 25, and the portion of the diaphragm 24 extending along the skirt 25' are spaced radially inwardly of the inner wall of the boss 31. This arrangement permits the poppet 21 to move axially into the boss 31 so that the piston 16 is exposed to the high pressure air in the chamber 11 (see FIGURE 2). In such movement of the poppet 21, the portion of the diaphragm 24 that lays along the skirt 25' of the upper disk 25 effectively rolls between the confronting surfaces of the skirt 25' and the boss 31.

To aid in establishing the desired operation of the poppet 21 and the piston 16, a rod-like element 32 is secured at one end to the upper end of the piston 16, and extends through the poppet 21 and into a central bore or cylinder 33 in the cap 30. The upper end of the rod 32 is provided with a piston head 34, which has an O-ring 35 located in a peripheral groove therein.

To ensure that the space in the cap 30 above the poppet 21 is effectively sealed from the lower portion of the poppet, an O-ring 37 is located in an internal groove in the bolt 27, and is in sealing engagement with the rod 32.

Normally, the poppet 21 is biased downwardly toward the position wherein its O-ring 23 seals against the upper end of the cylinder 15. To this end, a compression spring 38 is placed around the inner boss 36, and extends between the upper surface of the ring 25 and the radial transition surface of the cap 30 between the bosses 36, 31.

The interior of the cap 30 is normally connected to the cavity 11 of the housing 10, and in this manner the combination of the spring and the balanced air pressures on both sides of the diaphragm 24 maintain the poppet 21 in its lowermost position. To accomplish this, the interior of the cap 30 is connected to the cavity 11 through a port 39 in the cap, a fluid conduit 40 in the housing, such fluid conduit being aligned with the port 39, and a port 41 in a valve 42.

When it is desired to operate the piston 16 so that it is thrust downwardly, the interior of the cap 30 is sealed off from the cavity 11 within the housing 10, and is connected to the atmosphere to permit the pressure within the cap 30 to be reduced. Upon exposing the interior of the cap 30 to the atmosphere, the high pressure air within the cavity 11 is enabled to force the poppet 21 upwardly. Referring to FIGURE 2, such movement of the poppet 21 is initiated by the pressure exerted on that portion of the diaphragm 24 that extends across the space between the skirt 25' of the ring 25 and the inner wall of the boss 31. Immediately upon the seal engagement of the poppet 21 with the upper end of the cylinder 15 being broken, the high pressure air from the cavity 11 rushes into the upper end of the cylinder 15 to simultaneously accelerate the upward movement of the poppet 21 and to thrust the piston 16 down to its lowermost position.

To establish the desired connection of the interior of the cap 30 with the atmosphere, we provide a spool-like

valve stem 44 in the valve 42, with O-rings 45, 46 in the outer diameter portions thereof to sealingly engage the inner bore 47 in the valve body. As shown, the valve stem 44 is shaped so that only one of the O-rings 45, 46 can be in sealing engagement with the bore 47. Normally, the valve stem 44 is held downwardly by means of a compression spring 48.

The compression spring 48 extends from the upper end of the valve stem 44 to the lower surface of a cap 49 that is threaded onto the valve housing 42. As shown, the valve housing 42 is provided with O-rings 50 in its lateral surface both above and below the port 41 therein, whereby to prevent leakage of air along the lateral surface of the valve body. As shown, the valve body is secured in the housing 10, as by a setscrew 51.

The body of the valve 42 is provided with a vent or port 52 to the atmosphere, such port 52 being located above the valve stem 44. Thus, in the lowermost position of the valve stem, wherein its upper O-ring 45 sealingly engages the bore 47, the port 52 is sealed off from the interior of the valve, and hence is sealed off from the fluid connections 39-41 and the interior of the cap 30.

When it is desired to connect the interior of the cap 30 to the atmosphere, and to seal the interior of the cap 30 from the high pressure air in the cavity 11 within the housing 10, we arrange to move the valve stem 44 upwardly until the lower O-ring 46 therein engages the bore 47 below the port 41. To this end, the valve stem 44 is carried on one end of an elongated rod 54 that extends through the cavity 11 and to the exterior of the housing 10 below the hand grip portion 12 thereof. As shown, the lower end of the rod 54 is in the path of a pivotally mounted finger element 55. With this arrangement, a person is enabled, while holding the housing 10 by its hand grip portion 12, to place a finger on the element 55 and force the rod 54 upwardly.

As will be obvious, in order to connect the interior of the cap 30 to the atmosphere, the fluid connection 39 is not blocked by the diaphragm 24 when the poppet 21 is forced to its uppermost position. This will be seen by inspection of FIGURE 2.

As long as the rod 54 is held upwardly, the high pressure air in the cavity 11 causes the poppet 21 to remain in its uppermost position. However, when the finger element 55 is released, the spring 48 in the cap 49 forces the valve stem 44 downwardly, thereby closing off the outlet port 52 from the interior of the cap 30 and connecting the interior of the cap to the cavity 11 in the housing 10. This of course places the interior of the cap 30 in communication with the source of high pressure air. Such high pressure air and the force of the compression spring combine to overcome the high pressure air against the lower surface of the poppet 21, thereby causing the poppet 21 to be moved to its lowermost position wherein the O-ring 23 seals off the upper end of the cylinder 15 from the interior of the cavity 11. In other words, with the same air pressure on both sides of the poppet, the poppet is readily moved downwardly by the spring to its normal position.

At this point, a unique provision or feature of our invention is brought into play to cause the piston 16 to be raised to its uppermost position. As will be apparent, when the poppet 21 is returned so that the O-ring 23 seats against the upper end of the cylinder 15, the air pressure in the interior of the cylinder 15 is sufficient to keep the piston 16 in its lowermost position. It is necessary to bleed this air off in order to allow the high pressure air within the cap 30 to engage the piston head 34 and force it upwardly so as to raise the piston 16 to its desired position.

While prior art pneumatic devices are characterized by elaborate valve arrangements to bleed off air in permitting their driving pistons to move to their initial positions, our invention incorporates a feature of utmost simplicity and

design. Such bleeding of the air is accomplished through a small vent or port 56 that is located adjacent the upper end of the cylinder 15.

As will be seen, immediately upon the poppet 21 seating against the upper end of the cylinder 15, the air thus trapped within the cylinder 15, which is higher than atmospheric pressure, is vented to the atmosphere through the port 56. Thereupon, the high pressure air against the lower surface of the piston head 34 in the cap 30 becomes operative to force the piston head 34 upwardly, whereby the rod 32 and the piston 16 are forced upwardly. This upward movement of the piston 16 continues until its upper surface engages the lower end of the nut 28.

To drive corrugated nails, we employ a magazine 60 that includes a channel-shaped element 61 that is located below the cavity 11 and the hand grip portion 12 of the housing 10. Within the channel member 61, we provide a pusher block 62 for corrugated nails 63 that are located in and extend across the width of the channel member 61. As best seen in FIGURE 4, the nails 63 are of the type arranged in a row in non-nesting relation. The pusher block 62 is carried on an arm 64 (see FIGURE 1) that extends above the channel member 61.

A rod 65 of substantially the length of the channel member 61 extends through the arm 64, and at its outer end is secured to the housing 10, as by a bracket 66 that is secured to the rod 65 and which is releasably locked to the housing 10. An elongated compression spring 67 surrounds the rod 65 and extends between the arm 64 and the bracket 66. With this arrangement, the pusher block 62 is constantly urged towards the front of the channel member 61, whereby to keep a stack of nails biased toward such front end of the channel member 61. In this connection, a stop for the arm 64 is provided by a bridge element 68 that extends across the top of the channel member 61. The stop member 68 is engaged by the arm 64 in the forwardmost position of the pusher block 62.

The hammer blade 17 is provided with guide means to enable it to eject nails in the desired manner. Referring to FIGURE 4 along with FIGURES 1 and 2, such guide means is provided by a pair of plates 70, 71 extending below the cylinder 15. The plates 70, 71 which are secured to the adjacent portion of the housing 10 and across the end of the channel member 61, together define an opening 72 that conforms to the configuration of the hammer blade 17. As shown in FIGURE 3, the hammer blade 17 is formed as a flat plate having side rails 17' extending from one surface thereof. The front plate or nose plate 70 is provided with grooves into which the side rails 17' extend. The plate 71 functions as a back-up plate, against which the flat surface portion of the hammer blade 17 rides.

As shown, the side rails 17' terminate adjacent the bottom or lower end of the hammer blade 17, whereby to leave only a very short thin blade section that projects below the lower ends of the plates 70, 71 when the piston 16 moves to its lowermost position. The width or thickness of this thin blade portion is equal to or less than the thickness or width of a corrugated nail. The opening 72 through which the hammer blade 17 passes is sufficiently wide to permit a corrugated nail urged by the pusher block 62 to be positioned therein.

It will be understood that the corrugated nails are arranged in a row and are held together by a suitable adhesive material, so that the corrugated nail located in the opening 72 is held against the adjacent surface of the front plate 70. Accordingly, when the blade is thrust downwardly, the end thereof effectively separates the corrugated nail directly in its path from the remainder of the stack. The separated nail is carried with the blade and thrust into materials located immediately below them.

FIGURE 6 illustrates more clearly the preferred form of hammer blade for use in our invention. The hammer blade 17 is shown above a line of abutment between two

wooden panels 74, 75, and a corrugated nail 76 is positioned between the lower end of the hammer blade 17 and the panels 74, 75. The corrugated nails, as indicated by the nail 76 shown in FIGURE 6, are elements in which the upper and lower edges are substantially parallel. We construct the lower end of the hammer blade 17 with a very slight taper from the sides, as indicated at 77, 78, to a central point 79. With this arrangement, the sudden downward movement of the hammer blade 17 results in the point 79 causing the center portion of the nail to be the initial portion to enter the panels 74, 75. Obviously, the nails must be of sufficient length, and the speed and force of the blade against the nail must be sufficient, to permit a degree of lateral constriction of a nail to accomplish this result. Such action effectively creates a "drag" on those portions that are entering the surfaces of the panels 74, 75 on either side of the junction, whereby to effectively pull the panels together.

Our apparatus is also arranged to permit the operator to visually inspect the end of magazine adjacent the plates 70, 71. To this end, we provide aligned openings 80, 81 in the lower portions of the plates 70, 71. When the blade 17 is raised, one can look through the openings 80, 81 and see, for example, whether the supply of staples in the magazine is almost used up. By visual inspection, the chances are minimized that the apparatus will be "fired" without driving a nail and thereby cause an undesired shock to the blade 17.

In this connection it should be noted that since the enlarged head 18 of the blade 17 is carried in a keyway in the piston 16, an unimpeded snap movement of the blade creates undesirable stresses on the blade adjacent its enlarged head 18, and also on the walls of the keyway in the piston.

These stresses tend to split the piston and to shear the body of the blade off its head 18. While careful selection of the materials for the piston and the blade may minimize these effects, such shocks cannot be withstood indefinitely. Hence, our provision for visual inspection enables the operator to see whether a nail is in the magazine for the blade to drive. If the magazine is seen to be empty, the operator will know not to fire the apparatus until it is reloaded. The life of the apparatus will thus be markedly extended.

While we have illustrated and described a particular embodiment of our invention, it will be apparent that various modifications can be made therein without departing from the spirit and scope of our invention. Accordingly, we do not intend that our invention be limited, except as by the appended claims.

We claim:

1. Pneumatic power apparatus comprising: a housing having a pair of spaced coaxial cylinders therein, said housing having a chamber into which to admit air under pressure, said chamber extending to the space between said cylinders, one of said cylinders having a vent opening to the atmosphere intermediate its ends, said vent opening being a small fraction of the sizes of the confronting ends of said cylinders or the space between them, the other cylinder having a vent to the atmosphere from the end thereof opposite said one cylinder; respective pistons slidable in said cylinders; a rod connected at its ends to said pistons; a poppet in the space between said cylinders, said poppet surrounding and slidable on said rod, said poppet being movable between first and second positions in said space to abut the adjacent ends of the respective cylinders; a seal carried on said poppet engaging the adjacent end of said one cylinder when said poppet is in said first position; spring means continually urging said poppet toward said first position; a port connection to said other cylinder; valve means for selectively connecting said port connection to said chamber and to the atmosphere; and a flexible diaphragm encircling said poppet, said diaphragm having a central portion secured to said poppet, the rim of said diaphragm being clamped to said

housing adjacent the inner end of said other cylinder, whereby to prevent direct fluid communication between said other cylinder and the space between said cylinders, said diaphragm being of a length to readily permit said poppet to move from one to the other of said first and second positions without blocking said port connection.

2. Pneumatic power apparatus as defined in claim 1, wherein said valve means includes a two-position valve slidable transversely through said port connection, said valve in one position connecting said port connection in fluid communication with said chamber, and in another position connecting said port connection to the atmosphere; and spring means biasing said valve to said one position.

3. Pneumatic power apparatus as defined in claim 1, in which a driving element extends from the opposite end of said one cylinder to the exterior of said housing, the inner end of said driving element being enlarged, said piston in said one cylinder having a mating keyway in which the enlarged end of said driving element is located.

4. Pneumatic power apparatus as defined in claim 3, including guide elements exteriorly of said one cylinder between which said driving element is movable, said guide elements having aligned openings adjacent their outer ends; and a magazine with feed means for supporting and feeding a row of corrugated nails toward said guide elements to permit said driving element to separate individual nails from the row and eject them from the magazine.

5. A pneumatic power device comprising: a housing having a chamber into which to admit air under pressure, said housing having a cylinder therein adjacent said chamber to be selectively blocked at one end from fluid communication with said chamber, said cylinder intermediate its ends having a vent connection to the atmosphere; a piston slidable in said cylinder; a poppet adjacent said one end of said cylinder and intermediate said cylinder and chamber, said poppet being movable between first and second positions along the axis of said cylinder; a seal carried by said poppet, said seal engaging said one end of said cylinder in the first position of said

poppet, and being spaced from said one end of said cylinder in the second position of said poppet; spring means normally biasing said poppet to its first position; a port connection to a portion of the housing spaced from the end of said poppet remote from said one end of the cylinder; valve means for selectively connecting said port connection to said chamber and to the atmosphere; and a diaphragm encircling said poppet having a central body portion secured to said poppet and a rim clamped to said housing intermediate said port connection and the portion of said chamber adjacent said cylinder, said diaphragm being dimensioned to readily permit movement of said poppet between said first and second positions.

6. A pneumatic gun apparatus for dispensing corrugated nails, comprising in combination: magazine means for supporting corrugated nails so that they may be dispensed one at a time therefrom to enter abutting panel elements and secure them together; a piston; a substantially rectangular hammer blade having one end coupled to said piston so as to be driven thereby and having an opposite striking end positioned for engaging and ejecting individual nails from said magazine means, said striking end having a V-shaped configuration with a central apex for first engaging a corrugated nail upon actuation of said piston to eject the nail from said magazine means and against the abutting panel elements; and means for applying driving power to said piston at a speed sufficient to cause the nail to generally conform to the V-shape of said striking end during entry of the nail into the abutting panel elements, whereby the nail is laterally constricted to draw said panel elements closely together.

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