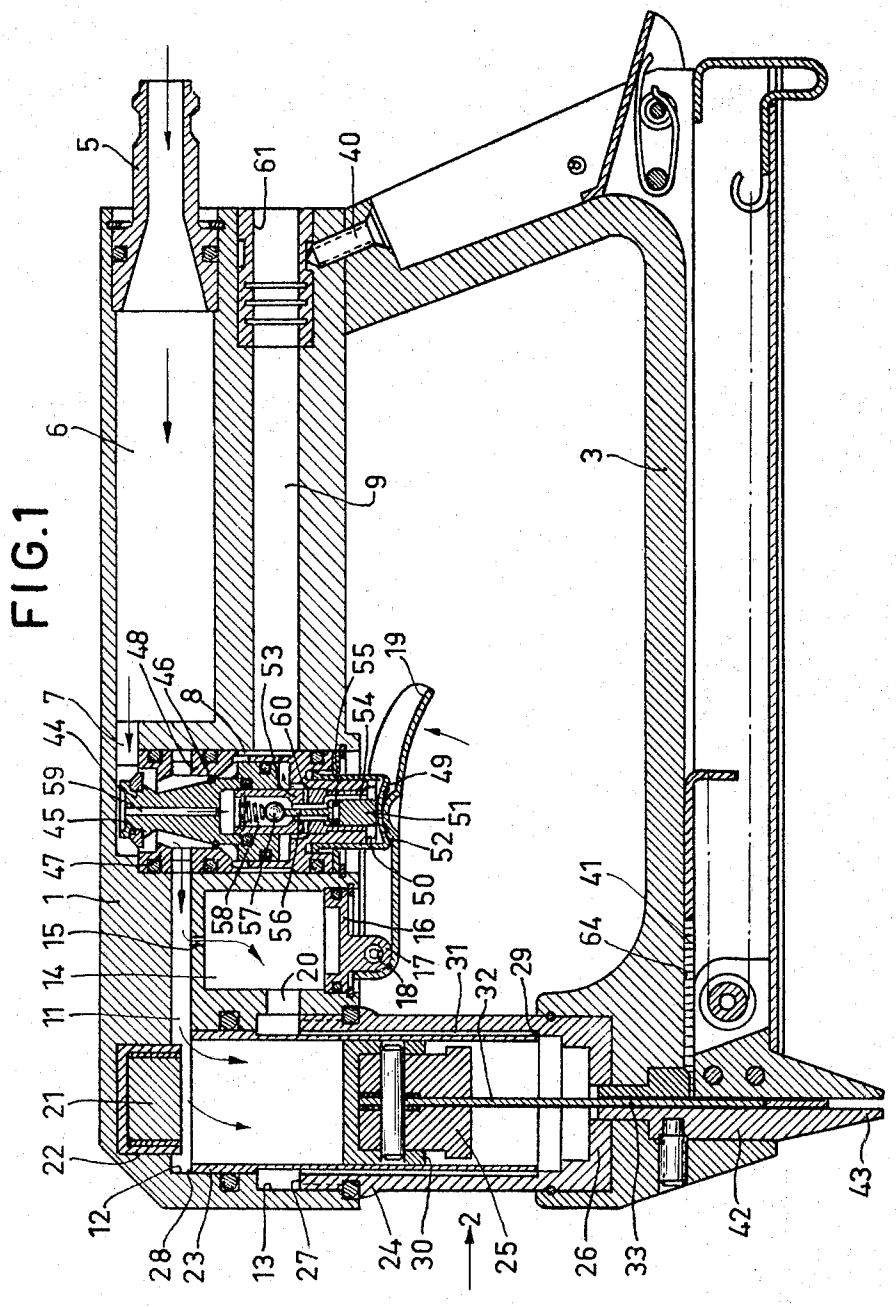
June 6, 1967 R. ÅKE G. LYSELL 3,323,602

PNEUMATICALLY OPERATED STAPLER, NAILING APPARATUS OR THE LIKE

Filed Oct. 19, 1964 2 Sheets-Sheet 1

FIG.1



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Filed Oct. 19, 1964 2 Sheets-Sheet 2

FIG.2

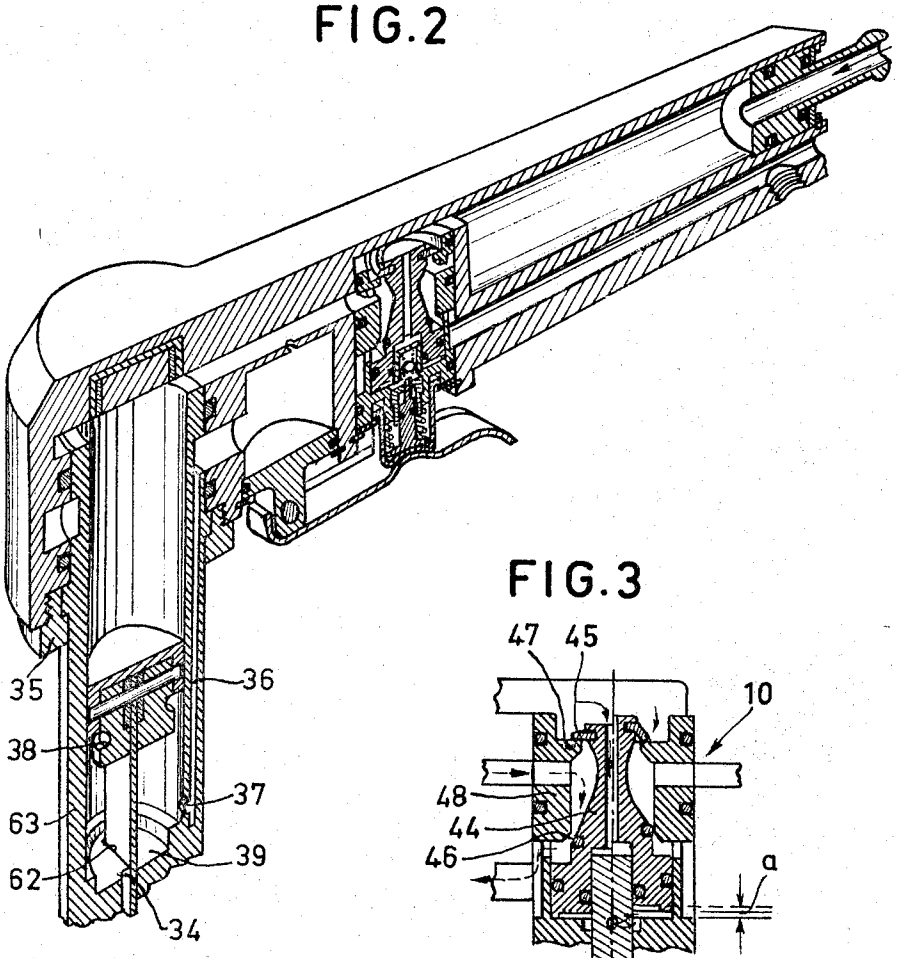


FIG.3

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PNEUMATICALLY OPERATED STAPLER, NAILING APPARATUS OR THE LIKE

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8 Claims. (Cl. 173—169)

This invention relates to a method of driving by compressed air a piston adapted to reciprocate in a cylinder for fastening staples, driving nails or the like, and to an apparatus for carrying out the method.

In a conventional pneumatically operated stapler a piston arranged in a cylinder is adapted while carrying out the working stroke for driving a staple to press the air below the piston through apertures in the lower portion of the cylinder jacket into a return air container enclosing the cylinder, in order to utilize thereafter the air thus compressed for effecting the return movement of the piston. During the first phase of the downward piston movement for said working stroke, the cylinder space below the piston communicates with the ambient atmosphere through an opening provided in the cylinder bottom, said opening being sealed during the remaining part of the piston movement by means of a piston rod attached to the piston for effecting the aforesaid compression, said piston rod being guided through said opening and acting as a driving member for the staple. However, when the piston is driven in this manner, a substantial air cushion is formed below the piston and renders it impossible to obtain a full effect of the working stroke. There is, further, the disadvantage that it is not possible to build up an air pressure as high as desired for giving satisfactory effect also to the return movement of the piston.

In another conventional construction comprising a working cylinder enclosed by a return air container, the cylinder wall is provided with overflow holes to the return air container, said holes being equipped with check valves, so that the return air container is not supplied with compressed air unless the piston has reached its lower end position and thereby has exposed the said overflow holes which are equipped with valves. However, even this construction involves several shortcomings. In order to be able to operate the apparatus at a satisfactory speed, the overflow holes must be given a relatively great size. As a result thereof, the air thus evacuated through said holes reduces the effect of the piston in the most critical phase of its working stroke. Moreover, the valve mechanism is sensitive to impurities in the compressed air.

The aforesaid disadvantages are eliminated by the present invention which refers to a method of driving by compressed air a piston adapted to reciprocate in a cylinder for effecting the fastening of a staple, driving of a nail or the like, the compressed air being supplied and abducted through a passage arranged to the cylinder above the pressure side (upper surface) of the piston and connected with an inlet or outlet via a valve. The method is substantially characterized in that during all the time compressed air is supplied to the pressure side of the piston for effecting the downward working stroke of the piston, part of the supplied compressed air is utilized, but at a relatively lower speed, to build up an air pressure to the side of the cylinder, which air pressure upon adjustment of the valve to establish connection between the said passage and the outlet causes the piston to be moved back into its starting position.

As by this method the air below the piston is not utilized to build up the pressure in a return air container, there is consequently no such air cushion of stroke-impeding effect as it is obtained in the previously known

constructions. For effecting the return movement of the piston, a high air pressure is built up during a longer period which provides a strong initial force for said movement without at the same time giving rise to the aforesaid disadavntages. The result is a considerable gain in operation speed with high working stroke effect.

The valve is preferably caused to shut the connection between the passage and the outlet before the valve by rapid action opens full connection for the compressed air to the pasage, thereby exposing the pressure side of the piston instantaneously and shock-like to the full pressure of the compressed air acting for effecting the working stroke of the piston. This feature constitutes a substantial development of the invention, as hereby due to a powerful instantaneous thrust at full pressure a driving of the piston is obtained which is highly effective also for the working stroke. There is, furthermore, neither any air loss in the valve.

The invention also relates to a stapler, nailing apparatus or the like for utilizing the aforesaid method, said apparatus comprising an inlet and an outlet adapted to be opened and closed by a valve for alternating connection to a passage arranged after the valve, said passage extending to the upper portion of a cylinder above a piston reciprocated in the cylinder by the compressed air supplied thereto, said apparatus being substantially characterized by a preferably adjustable nozzle or the like mounted in the passage after the valve, said nozzle connecting the passage with an air space to the side of the cylinder, which air space communicates with the interior of the cylinder through one or a plurality of openings in the lower portion of said cylinder.

The apparatus according to the invention which renders the aforesaid advantages is constructed in a very simple manner, among other due to the fact that there is no need for arranging valves to the air space. The apparatus is also highly economical from a compressed air point of view.

The invention will be described in greater detail in the following, reference being had to the accompanying drawing showing an embodiment of a stapler according to the invention.

FIG. 1 shows a side view of the stapler, the parts required for its operation being shown in a section along a longitudinal plane of symmetry and during the working stroke for the drive mecahnism of the apparatus,

FIG. 2 shows in a perspective view the aforesaid section of a slightly modified stapler during the return movement for the drive mechanism,

FIG. 3 shows in a section a piston valve operating in the apparatus in two positions for the valve piston.

As appears from FIG. 1, the stapler comprises three main parts, viz a handle portion **1**, a working cylinder portion **2** detachably arranged at one end of said handle, and a lower portion **3** fastened to the opposite end of said handle.

The handle portion **1** is made in one piece and comprises all parts required for the operation (drive mechanism). Into the end fastened to the lower portion **3** a pivoted hose nipple **5** for compressed air supply is inserted in a recess **6** which serves as compressed air storage container. Said container communicates via a passage **7** with the upper portion of a recess **8** which also communicates with the ambient atmosphere via a vent line (outlet) **9** below the said air storage container **6** with a muffer **61** mounted in the outlet end. A valve **10** (see FIG. 3) mounted in the recess **8** will be described below in greater detail. Said valve is adapted to open and close the inlet and outlet for alternating connection of the same to a passage **11** extending to the upper portion of a recess **12** having a lower recess **13** of greater width which is provided with internal threads for screw connection with the

cylinder portion 2. The passage 11 communicates with an air chamber 14 via an opening 15 into which may be inserted a nozzle (not shown) adapted to be adjusted with respect to its size. The bottom of said air chamber comprises a bottom plate 16 which supports in a portion 17 projecting from the handle portion a shaft 18 about which is rotary mounted a trigger-like member 19 for actuating the valve 10. The size of the air chamber volume can easily be adjusted by arranging a bottom plate of varying thickness. A passage 20 extends from the air chamber 14 to the recess 13. A magnet 21 is mounted in a recess 22 in the handle portion 1 centrally above recess 12.

At the handle portion 1 may now be provided a working cylinder portion 2 of optional length adjusted to the recesses 12 and 13. As appears from FIG. 1, said working cylinder portion comprises a tubular working cylinder 23 and an external cylinder 24 with a bottom, which cylinder is arranged concentrically with cylinder 23 and in threaded connection with the handle portion. Within the working cylinder 23, the working piston 25 can be moved by the supplied compressed air between an upper end position where it is retained by the magnet 21, and a lower end position where it seals against the bottom 26 of the external cylinder, which bottom is shaped to fit the working piston. The external cylinder 24 is preferably constructed such, that it extends with its upper edge 27 to the passage 20, the working cylinder being fitted with its upper portion in the recess 12 and lying with its upper edge 28 on the same level as the lower edge of passage 11 and terminating downwardly with an intermediate space 29 to the bottom 26 of the external cylinder. The working piston 25 and the cylinder 24 are designed such, that they sealingly engage with one another below the said space 29, so that during the final phase of the downward movement of the piston a space is formed which extends all around and is sealed against both cylinders, said space having an upper pressure surface 30 and communicating via the intermediate space 29 with the space 31 between the cylinders and thereby with the passage 11 over the passage 20, air chamber 14 and opening 15. The working piston further comprises a piston rod 32 which is in constant engagement with and guided in a guide channel 33 placed in a guide member 42 associated with the lower portion 3. In conformity with what is shown at 34 in FIG. 2, a vent groove is arranged in the cylinder bottom 26 for evacuating air below the working piston during the downward movement. FIG. 2 shows another embodiment of the cylinder portion 2 and a recess of a slightly different shape to fit with the handle portion, in which recess the cylinder portion is secured by a lock ring 35. The cylinder portion comprises only one cylinder 63 with a passage 36 (or several passages) provided in the jacket, said passage being connected with its upper portion to the passage 20 and with its lower portion via an opening 37 (or several openings) to an otherwise closed groove 38 in the working piston during the final phase of the downward movement of the piston, in like manner as in the foregoing embodiment. The piston rod is shown in this figure to be guided by a hole 62 provided in the cylinder bottom to fit the shape of the rod. The evacuating groove 34 is located to the side of said hole.

The cylinder portion 2 is arranged in a suitable manner at the lower portion 3 which, for example by a screw 40, is fastened to the handle portion 1. The cylinder portion and the lower portion are even in a preferred embodiment made integral. In said lower portion 3 the staples 41 are fed automatically one after the other in a feed channel 64 designed according to the shape of the staples to the guide passage 33 and are driven by the piston rod 32 through the nose 43 of the guide member 42 into a workpiece placed below.

For this operation, the piston rod is shaped in a manner adapted for cooperation with the staple, in this embodiment like a longitudinal rod with rectangular cross-

section. The embodiment refers to a stapler, but the invention may be applied as well to a nailing apparatus or other apparatus to be used for driving a fastening means. The lower portion as well as the driving piston rod and its guide means may in such cases be designed in a different way to correspond to the fastening means employed.

In the following the valve 10 mounted in the recess 8 will be described in greater detail, which valve due to its special construction contributes to a high degree to the effective operation which characterizes the apparatus according to the invention. As already mentioned, the valve 10 is actuated by the trigger 19 whereby the integral main piston 44 of the valve can be displaced from a normal lower position wherein the valve maintains the connection between the supply passage 7 and the passage 11 closed but the connection between the passage 11 and the discharge passage 9 open, to an upper position wherein the valve is open for the supply of compressed air to the passage 11 but wherein the discharge outlet is closed. In order to effect the said alternating connection to passage 11, the main piston 44 of the valve is provided at its upper portion to the passage 7 with an elastic valve plate 45 and at its lower portion between the passage 11 and the discharge passage 9 with a sealing ring 46. The valve plate 45 cooperates with the upper surface of a flange 47 extending inwardly from the valve housing, and the sealing ring 46 coopertaes with a portion 48 of the valve housing which first is shaped upwardly conical and then cylindrical. The trigger 19 provided for actuating the main piston 44 abuts to a sleeve 49 adapted to be moved upwards against the action of a spring 50. A release piston 51 abutting to the sleeve 49 is displaceable upwards in a cylinder 52 to an inwardly widened portion 53 in the central section of said cylinder. Evacuating grooves 54 are provided to the side of piston 51, which at its upper portion has a sealing ring 55 sealing in the upper position of the piston against the cylinder wall and, thus, maintaining in this position the said evacuating grooves closed. The piston 51 further is provided with a piston rod 56 projecting with intervals through the narrower central portion of the cylinder 52 to abut against a valve ball 57 in the upper portion of the cylinder. The said valve ball is normally kept pressed by the spring 58 against the upper surface of the widened portion 53 which is formed to serve as a seat for said ball. The cylinder space above the valve ball is in permanent connection with the compressed air passage 7 above valve 10 through a central bore 59 in the main piston 44. The actuation of valve 10 is effected as follows. When the trigger 19 is being moved upwards, even the release piston 51 is moved upwards and lifts by means of the piston rod 56 the valve ball 57 from its seat, at the same time as the sealing ring 55 closes the evacuating grooves 54. Compressed air flows now downwards to the side of piston rod 56 and through passages 60 in the central portion 53 of the cylinder to the lower surface of the main piston 44 which, due to the fact that the pressure area of the lower surface exceeds in size the sealing surface is pressed upwards, in such a manner, that the sealing ring 46 first gets into contact with the conical portion of the valve housing portion 48 and after an additional slight displacement establishes full engagement with the cylindrical portion of the portion 48. In this way, a soft successive engagement is obtained. What is particularly essential in connection with the valve in question is the fact that, besides its simple and reliable construction with an undivided main valve piston, the elastic valve plate 45, in spite of the piston movement, maintains sealing contact with its valve seat due to the air pressure from above until the sealing ring 46 reaches its sealing position, at which moment the valve plate momentarily gets out of its position. As a result thereof, the compressed air is supplied through the passage 11 to the upper surface of the working piston 25 with

a shock-like effect and subjects said surface to a powerful thrust with full pressure and without air loss in valve **10**. This is of special importance, because the said thrust is carried out in a critical phase for obtaining rapid piston movement and thereby high stroke effect, i.e. when the piston is retained in its uppermost end position by the magnet **21**. Upon releasing the trigger **19**, the valve ball **57** again can seal against its seat, and the air below the main piston **44** is evacuated through the grooves **54** now exposed. The main piston is forced down by the air pressure from above, the sealing ring **46** exposes the outlet passage **9**, and the valve plate **45** again seals against its seat. As a further advantage of the said valve construction may be mentioned that the total piston movement (*a* in FIG. 3) is very short, in a preferred embodiment only 1.7 mm.

The stapler operates as follows. When the compressed air, upon turning the trigger **19** upwards in the aforedescribed manner is supplied with shock-like effect to the upper surface of the working piston **25**, said piston is forced downwards at high speed at the same time as the air chamber **14** is supplied with compressed air through the opening **15** at a relatively lower speed. As soon as the lower edge of the working piston has passed the opening **37** and the intermediate space **29** respectively, the air chamber **14** is shut off entirely from connection with the interior of the cylinder, while connection is established with the groove **38** and the space extending all around respectively. As long as the trigger is maintained in its upper position, both the cylinder and the air chamber remain filled with air under pressure. Upon releasing the trigger, which as described before causes the valve to close the supply passage **7** and to open the discharge passage **9**, the air above the piston is evacuated rapidly through the passage **11** and discharge passage **9**. Hereby the piston is forced upwards with high initial power by means of the air pressure built up to the side of the cylinder. The air in the air chamber evacuates only to an insignificant part through the opening **15** and flows due to its overpressure in relation to the pressure in the cylinder through the opening (or openings) **37** and the intermediate space **29** respectively to the lower surface of the piston.

The stapler according to the invention, as appears from above information, is of particularly simple construction and design. It is easy and cheap to manufacture and can be assembled without difficulty. As already mentioned, the handle portion **1** is made in one piece and comprises all details required for driving the working piston whereof only valve **10**, the bottom plate **16** of the air chamber (enabling adjustability) and the magnet **21** are separate details but easy to mount. The described mounting of the magnet is of advantage in that full guaranty of parallelity can be obtained between the cooperating surfaces of the magnet and piston, thereby ensuring safest possible fastening. This is in many cases not ensured in conventional constructions wherein a screw cap comprising the magnet is screwed above the working cylinder. As also mentioned before, a working cylinder portion **2** of optional length is easy to attach to the handle portion.

The invention, of course, is not restricted to the above embodiments but may be modified in several different ways within the scope of the following claims.

What I claim is:

1. A pneumatic driving device for a stapler or the like, comprising a cylinder, a driver piston reciprocably mounted on said cylinder, an air reservoir for supplying compressed air to said cylinder, means forming a channel between said reservoir and the top of said cylinder above said piston, an outlet for exchanging air from said cylinder and connected to said channel, valve means for alternate connection of said reservoir and said outlet to said channel, and a return air chamber having a first passage always open to said channel and a second passage always open to the lower part of said cylinder below a pressure surface of said piston, said first passage being located between said valve and said cylinder and having a substantially less cross section than the cross section of said channel and also having a substantially less cross section than the said second passage.

2. A device according to claim **1**, and in which the said valve means comprises a valve housing, a valve piston reciprocably mounted in said housing, operating means for actuating said valve piston, and at least two seals arranged between said valve piston and said valve housing, one of said seals sealing to said reservoir when said outlet is open to said channel and being constructed and designed such, that it moves out of its sealing engagement with shocklike effect when the other sealing has completely closed and the outlet from said channel, thereby momentarily establishing full connection between said reservoir and said channel.

3. A device according to claim **2**, and in which one of said seals is an elastic valve plate.

4. A device according to claim **1**, and in which the opening of said second passage to said cylinder is located above the bottom of the cylinder, said opening being closed by said piston from the bottom of the cylinder before the piston reaches it lower end position on its downward working stroke, said piston being provided with a groove establishing the connection from said air chamber to said cylinder.

5. A device according to claim **4**, wherein all means required for driving the piston are mounted in a one-piece handle portion of the device to which the cylinder portion is detachably attached.

6. A device according to claim **1**, and in which said return air chamber is provided with a bottom plate which is detachable, rendering it possible to adjust the size of said chamber by changing the thickness of said bottom plate.

7. A device according to claim **6**, and in which said bottom plate is provided with a portion located outside of said handle portion, a shaft supported on said outside portion, and said operating means for said valve pivoted on said shaft.

8. A device according to claim **5**, and in which a magnet is provided for retaining the piston in its upper end position, said magnet being arranged centrally above the cylinder and having a plain lower surface facing the upper surface of the piston, said handle portion having a recess in which said magnet is mounted, thereby ensuring parallelity between the cooperating confronting surface of said magnet and said piston.

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