

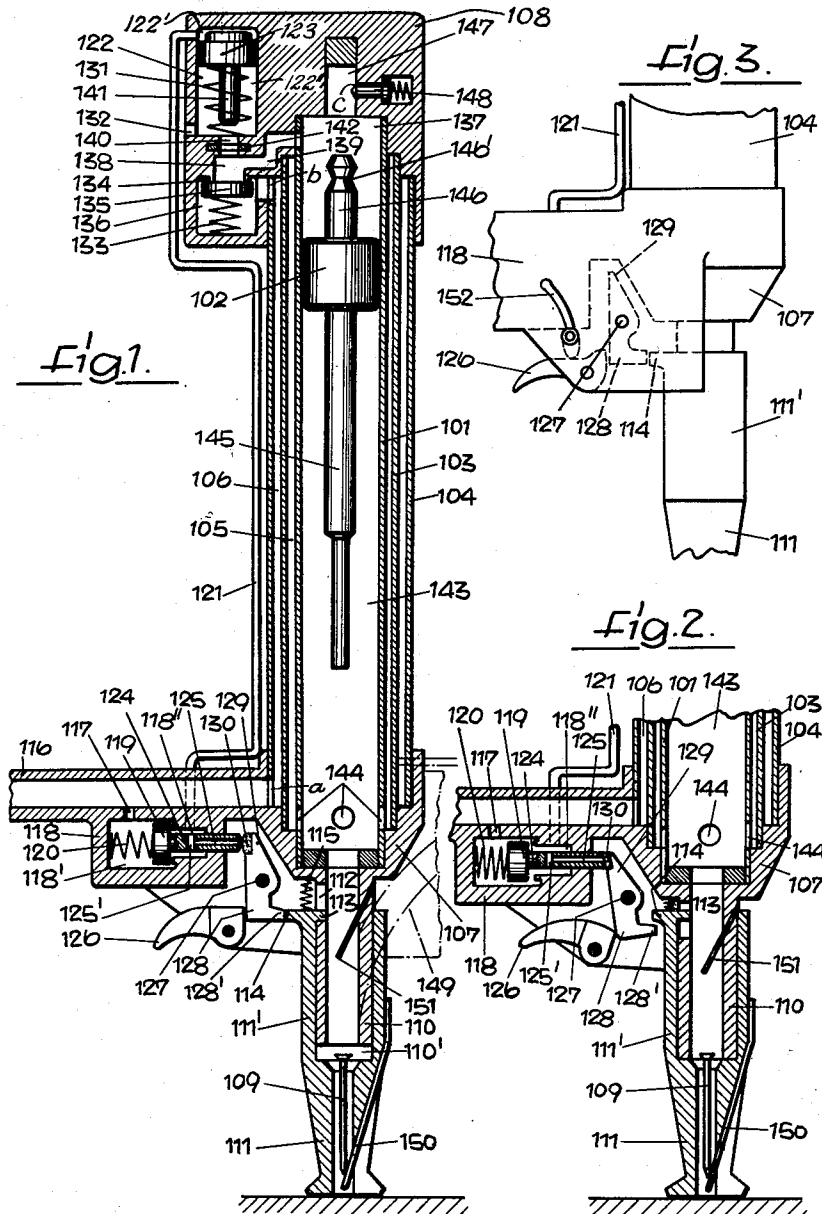
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A. CAST ET AL
NAILING APPARATUS

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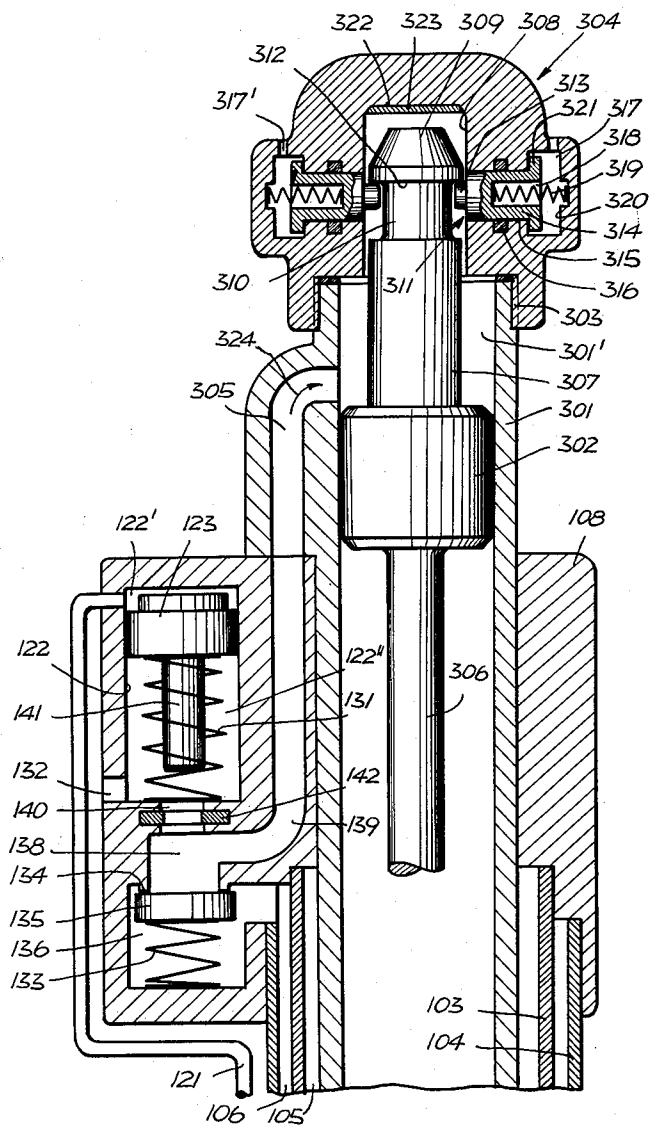
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Fig. 4.



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NAILING APPARATUS

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This present invention relates to a nailing apparatus which is operated by means of compressed air whereby a piston which is slidable within a cylinder acts upon a nail or the like which is held in a suitable guiding member connected to the cylinder to drive such nail or the like into a wall or other object.

The present invention is based upon the new concept that a considerable improvement of different factors which are of importance in apparatus of this type, such as the recoil, the air supply, and the weight of the apparatus may be attained by making the cylinder of the apparatus as slender as possible without changing the volume thereof, that is, by reducing the inner diameter of the cylinder and increasing the length of the cylinder and the stroke of the piston as much as possible. However, the more slender the piston is made, the greater will be the difficulty of making a suitable coil spring for returning the piston, and because of its great length as required by the long piston stroke, such a coiled return spring cannot be applied beyond a certain limit of slenderness of the cylinder.

In order to overcome this disadvantage there have been various proposals of compressed-air operated nailing apparatus which operate with pistons which are acted upon at both sides, that is, at one side during the working stroke and at the other side during the return stroke. However, such double action upon the piston requires a special control mechanism for reversing the direction of the compressed air current. Furthermore, as compared with an apparatus with a piston which is acted upon only at one side, the operation of such a double acting piston requires a considerably higher supply of compressed air since it also has to be used for returning the piston. Through its requirement of a special control mechanism, its increased weight, and increased use of compressed air, the cost of manufacture as well as the cost of operation of such a nailing apparatus with a piston which is acted upon at both sides are considerably higher than those of a similar apparatus with a piston which is driven by compressed air only to carry out the working or nailing stroke.

Another known nailing apparatus operated with compressed air provides a vacuum cylinder in front of the working cylinder for carrying out the return stroke of the piston. The piston rod of the ram piston extends through a partition into the vacuum cylinder and is there provided with a second piston. While the piston rod carries out its working stroke, it therefore also drives the piston within the vacuum cylinder and produces a vacuum therein so that the return stroke of the main piston is produced by atmospheric pressure. However, the necessary extension of the work cylinder by the vacuum cylinder required for the return of the piston results in a considerable increase in the total length of such a nailing apparatus which makes the apparatus quite heavy and difficult to manipulate. A further disadvantage of these prior apparatus is the fact that two pistons have to be ground into the cylinders which also increases the cost of manufacture considerably. Furthermore, this apparatus can function properly only if not only the pistons themselves have a tightly sealing fit, but also the piston rod within the partition between the vacuum

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cylinder and the work cylinder since otherwise compressed air would enter into the vacuum chamber and prevent a proper operation of the apparatus.

It is the principal object of the present invention to provide an apparatus for driving nails or the like into walls or other objects in which the piston is returned without the use of a spring and in a manner so as to avoid the disadvantages of an apparatus which operates by means of a vacuum cylinder, as well as of those apparatus which operate with pistons which are acted upon at both sides.

For attaining this object, the present invention provides the nailing apparatus with an air storage chamber which communicates with the cylinder at the side of the piston which is not acted upon by compressed air and at a point near the end of the working stroke of the piston, and in which the air which the piston expels from the cylinder during the working stroke is stored up and compressed for effecting the return stroke of the piston.

This requires that the inlet valve for the compressed air be shut very promptly since the return stroke of the piston which is effected by the stored-up air which is expelled from the cylinder during the nailing stroke would otherwise be retarded by the compressed air belatedly entering into the cylinder, and it would require such an amount of the stored-up energy to overcome such back pressure that the remainder of such energy would not be sufficient to return the piston completely.

There have also been prior nailing apparatus which were provided with a manually operated auxiliary mechanism for returning the piston. This auxiliary mechanism essentially consisted of a spring which was tensioned when the lever for operating the air inlet valve was actuated. When the tension of the spring had reached a certain limit, the air inlet valve was suddenly opened by the force of the spring. The present invention, however, is not primarily concerned with the sudden opening but with the sudden closing of the air inlet valve. This prior auxiliary mechanism is therefore not suitable for use in the apparatus according to the present invention.

It is therefore another object of the present invention to provide an auxiliary mechanism for suddenly closing the air inlet valve. Another feature of the invention for attaining this object consists in the provision of a pneumatically operated auxiliary piston which may be controlled by a manually operated auxiliary valve and, in turn, operates the main air inlet valve. This pneumatically operated auxiliary piston permits the air inlet valve to be shut very suddenly so that the waste of stored-up energy as above described will no longer occur.

This auxiliary piston and valve arrangement has the further advantage that it also permits a very sudden opening of the main air inlet valve. This is in contrast to those prior apparatus in which the air inlet valve is operated directly by hand and in which a certain delay necessarily occurs while the valve is being opened so that during the short period of the driving stroke the volume of air supplied to the piston, and therefore the power of the driving stroke is much smaller than that which would be supplied thereto if the valve would open instantly. Obviously, this reduces the efficiency of the entire apparatus considerably. For this reason, the above-mentioned auxiliary, hand-operated mechanisms have been designed which, however, can only be applied to smaller apparatus which only require relatively small amounts of compressed air. In larger apparatus in which a large volume of air has to pass through the valve within a very short time, such auxiliary appliance fails to operate for the following reason. For attaining the required cross-sectional area of flow for the passage of the air, the valve disk of the air inlet valve has to be

of a relatively large size. In order to be able to open such a large valve disk instantly, a spring would be required which would have to have a strength greater than that which could be applied by a finger to tension it to such an extent that the large valve disk could be opened instantaneously.

The pneumatically operated auxiliary piston according to the present invention may, however, be adapted without difficulty to any size of valve disk of the air inlet valve. This constitutes a valuable improvement in nailing apparatus. The invention is therefore also of great importance in all of those apparatus in which the return stroke of the piston is not produced by means of the air which is forced out of the cylinder and stored up in a compressed condition.

The auxiliary valve according to the invention may also be actuated instantaneously by means of a mechanical snap-action or tripping mechanism of any suitable type which is released by hand, for example, in the form of a spring for operating the valve, a locking bolt, or the like which maintains the spring in a tensioned condition, and a finger-operated trigger for unlocking the bolt and suddenly releasing the spring.

For insuring a proper operation of the apparatus according to the invention, the same is preferably provided with a device for arresting the striking piston at the end of the return stroke. However, practical experience has shown that, if the apparatus according to the invention is manipulated improperly, the piston may disengage from the arresting device and drop downwardly even though the inlet valve has not been operated. This may occur, for example, if the operator, after pulling the operating trigger, allows the apparatus to jump upwardly and then again to drop down. Although the piston will then at first snap backwardly and engage in the arresting device, the impact caused by dropping of the entire apparatus may again pull it out of the arresting device and cause it to drop. This may result in a subsequent improper nailing operation of the apparatus.

It is therefore another object of the invention to provide an arresting device which securely locks the piston in the retracted position and only allows it to be released therefrom when the inlet valve is opened.

This object may be attained by providing an arresting device which consists of a locking bolt which is made in the form of a piston which is slidable within the cylinder head and tightly sealed therein, and the end of which is adapted to engage into a recess in the ram piston to disengage therefrom by the action of the compressed air within the main pressure chamber of the cylinder. The piston will thus be securely held by the locking bolt at the end of the return stroke and be absolutely prevented from dropping, even though the nailing apparatus is manipulated improperly. However, as soon as the inlet valve is operated, the air pressure produced within the compression chamber forces the locking bolt out of its locking position so that the ram piston can be forwardly propelled by the action of the compressed air.

The means for forcing the locking bolt into the locking position may consist of a spring. The cylinder head is then preferably made in the form of a separate element which may be screwed upon the end of the cylinder and in which at least one locking bolt is mounted under the action of a spring. Such a design of the cylinder head has the advantage that any defects, for example in the proper sliding movement of the locking bolt, may be easily rectified and, furthermore, that the cylinder may be easily and quickly cleaned.

Another feature of the invention for attaining a secure locking of the piston in the retracted position consists in utilizing the compressed air within the air-inlet passage in front of the inlet valve as the force for maintaining the locking bolt in the locking position. The locking bolt and the bore in the cylinder head containing it are then each preferably made of two interconnected parts

of different diameters so that the part of the bore with a larger diameter in which the thicker part of the bolt is slidable terminates into the air inlet passage in front of the inlet valve, while the other part of the bore terminates into the air passage in front of the inlet valve. Such a design of the locking bolt and the bore within which it is slidable insures that the bolt will be forced into its locking position by the air pressure in the air passage in front of the inlet valve and that, at the moment when the inlet valve is opened, the air pressure within the cylinder will also act upon the thicker part of the locking bolt and force the same back from its locking position so that the ram piston will be released.

Further objects, features, and advantages of the present invention will be apparent from the following detailed description thereof, particularly when read with reference to the accompanying drawings, in which—

FIG. 1 shows a longitudinal section of an apparatus according to one embodiment of the invention;

FIG. 2 shows a partial view of the apparatus according to FIG. 1, but at a different stage of the operation;

FIG. 3 shows a side view of a part of the apparatus according to a modification of the invention;

FIG. 4 shows a longitudinal section of the upper end of an apparatus according to another modification of the invention;

FIG. 5 shows a view similar to FIG. 4 of still another modification of the invention.

Referring to the drawings, and first particularly to FIGS. 1 and 2, the nailing apparatus consists of a central cylinder 101 for guiding a ram piston 102 for a reciprocating sliding movement therein. Cylinder 101 is enclosed by two cylinders 103 and 104 extending concentrically thereto, thus forming a cylindrical chamber 105 between cylinders 101 and 103 and a cylindrical passage 106 between cylinders 103 and 104. The three concentric cylinders 101, 103, and 104 are connected so as to form a single unit by means of a cylinder foot 107 and a cylinder head 108.

The tubular end 110 of cylinder foot 107 which is designed to receive nails 109 or pins, rivets, or the like carries a nozzle member 111 which is slidable thereon in the axial direction and forms the end portion of the apparatus. A cylindrical part 111' of nozzle 111 which is slipped upon the tubular end 110 of cylinder foot 107 has at its upper end a stop portion 113 which engages into a slot 112 in the tubular end 110 of the cylinder foot, and another stop portion 114 projecting outwardly which is adapted to engage with a lever 128 of a trigger mechanism which will be subsequently described in detail. A coil spring 115 which is interposed between the cylinder foot 107 and the upper edge of nozzle 111, and preferably between stops 113 and 114, urges nozzle 111 into a position in which the stop portion 113 engages with the lower end of slot 112, as shown in FIG. 1.

Cylinder foot 107 is further provided with a lateral extension 116 forming the inlet conduit which is connected to a compressed-air line leading to a compressor, not shown. This inlet conduit 116 communicates through an aperture 117 with a pressure chamber 118' of an auxiliary valve 118 which together with inlet conduit 116 forms an integral part of cylinder foot 107 and contains a valve disk 119 which is held upon its seat by the compressed air and a compression spring 120. Pressure chamber 118' of valve 118 is connected to a smaller chamber 118'' from which it is separated by valve disk 119 and which communicates through a conduit 121 with a pressure chamber 122' of a cylinder 122 which forms an integral part of cylinder head 108 and in which an auxiliary piston 123 is guided. For operating the valve disk 119 of auxiliary valve 118, disk 119 carries on its seat side a stem 124 which extends through an opening in valve housing 118 to the outside thereof. Valve stem 124 has transverse bores 125' and an axial bore 125 through which the inner chamber 118'' of valve 118, and thus also pressure cham-

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ber 122' of the cylinder 122 through conduit 121, communicate with the outer air.

For operating the auxiliary valve 118, a trigger 126 is pivotally mounted within cylinder foot 107 and engages with a lever with two arms 128 and 129 which is pivotable about an axis 127 and adapted to act upon valve stem 124 of valve 118. The outer end surface of valve stem 124 forms a stop for terminating the movement of lever 128, 129. The upper arm 129 of this lever is designed so as to close the end of the axial bore 125 in valve stem 124 when in tight engagement therewith. For this purpose, arm 129 preferably carries a resilient disk or the like 130 so that, when arm 129 presses upon the end of valve stem 124, it forms an air-tight closure of the outer opening of bore 125.

The lower arm 128 of lever 128, 129 which is operatively associated with trigger 126 has a projecting stop portion 128' which, when nozzle 111 is in its normal position, engages directly with the stop portion 114 on the upper end of the nozzle. Therefore, in this position of nozzle 111, valve 118, 119 cannot be operated by trigger 126. If, however, the entire nailing apparatus is pressed upon a surface, nozzle 111 will be shifted toward the body of cylinder foot 107 against the action of spring 115, and stop portion 114 will then disengage from stop portion 128', as illustrated in FIG. 2, so that lever 128, 129 can then carry out the movement necessary to operate valve 118.

As already mentioned above, cylinder head 108 is provided with a cylinder 122 in which an auxiliary piston 123 is slidable. Cylinder 122 also contains a coil spring 131 which acts upon piston 123 and normally maintains the same in its uppermost position. The lower chamber 122' of cylinder 122 which is separated from pressure chamber 122' by piston 123 communicates with the outer atmosphere through an aperture 132.

Underneath cylinder 122, cylinder head 108 forms the body of a main air inlet valve, the valve disk 135 of which is pressed by a coil spring 133 upon its seat 134 and thus closes pressure chamber 136 of this main valve relative to pressure chamber 137 of cylinder 101. The upper valve chamber 138 which is separated from pressure chamber 136 by valve disk 135 communicates with pressure chamber 137 of cylinder 101 through a passage 139.

Valve chamber 138 also communicates with chamber 122' of cylinder 122 through a passage 140. This aperture 140 also serves as a passage for a stem 141 on piston 123 which is adapted to fit accurately into passage 140 so as to close the same when piston 123 is operated and to act upon valve disk 135 to open the same. In order to insure that stem 141 will form an airtight closure of passage 140, the same is preferably provided with a gasket ring 142. Pressure chamber 136 of the main control valve 135 communicates with the inlet pipe 116 through aperture b, the cylindrical passage 106 and aperture a.

Chamber 143 in cylinder 101 which is separated from the pressure chamber 137 by the ram piston 102 communicates through apertures 144 with the annular chamber 105 which serves as an air-storage chamber. When ram piston 102 moves downwardly within cylinder 101, the air which is expelled by piston 102 from chamber 143 will be stored up in chamber 105 in order to be used for returning piston 102 after the main valve 135 has been closed. For striking the nails or the like, ram piston 102 is provided in the usual manner with a ram rod 145, the upper part of which has a diameter so as to close the tubular end 110 of cylinder foot 107 when entering into the same and thus to prevent the air which is expelled from chamber 143 by piston 102 and which might pass from pressure chamber 137 into chamber 143 by flowing past the piston if the latter fits loosely into cylinder 101, from passing through nozzle 111 to the outside rather than to be stored up within the annular chamber 105. Ram piston 102 is further provided with a stem 146 which is adapted to pass into a cylindrical socket 147 at the upper

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end of cylinder head 108 when the apparatus is in the inoperative position and which is held in such position by means of a pin 148 which resiliently engages in an annular tapered groove 146' adjacent to the upper tapered end of stem 146.

Cylinder foot 107 is further provided with an inlet passage 149 which is known as such and therefore only indicated in FIG. 1 in dot-and-dash lines, for feeding the nails 109 into and through the tubular end 110 and then into the lower end of nozzle 111. In order to prevent the nails from falling out of nozzle 111 or from entering into cylinder chamber 143, springs 150 and 151 are provided in nozzle 111 and in the tubular end 110 of cylinder foot 107, respectively.

In the operation of the nailing apparatus as above described, it is first necessary to press the apparatus with nozzle 111 upon the surface into which a nail 109 is to be driven. Through such pressure the tubular end 110 on cylinder foot 107 is pushed downwardly until its front end engages with the bottom of the socket 110' in nozzle 111, as illustrated in FIG. 2, whereby stop portion 114 on the nozzle disengages from stop portion 128' on lever 128, thereby allowing trigger 126 to be pulled. Such pulling of trigger 126 pivots lever 128 about its axis 127 whereby the resilient disk 130 or the like on the upper arm 129 of the lever will be pressed against valve stem 124, the outer opening into bore 125 will be closed, and the auxiliary valve 118 will be opened so that the compressed air can pass from inlet pipe 116 through aperture 117 and the valve into conduit 121 and thus into pressure chamber 122'. This air pressure then forces piston 123 downwardly against the action of spring 131. Stem 141 on piston 123 then passes into passage 140 and thereby closes the same. By its further downward movement, stem 141 acts upon valve disk 135 of the main inlet valve and opens the same. The compressed air then passes from inlet pipe 116 through passage a, the cylindrical passage 106, passage b, valve chambers 136 and 138, and passage 139 into pressure chamber 137 where it acts upon ram piston 102 to force the same forwardly, whereby the tapered wall of groove 146' on stem 146 pushes pin 148 outwardly against the action of its spring so that stem 146 will be released from the holding action of pin 148, and ram piston 102 will be propelled along chamber 143 to hit upon the nail 109 in nozzle 111. During the downward movement of ram piston 102, the air from chamber 143 is expelled through apertures 144 into the cylindrical chamber 105 in which it is stored until, after the ram piston 102 has hit the nail, this stored-up air drives ram piston 102 upwardly toward the highest position so that the tapered end of stem 146 first pushes pin 148 outwardly and the latter then snaps into groove 146'.

This return movement of ram piston 102 proceeds in detail as follows:

As soon as trigger 126 is released, spring 120 forces valve disk 119 upon its seat, thus closing the valve. Since the intermediate lever 128, 129 is also released, the mouth of bore 125 will at the same time be opened so that the compressed air can flow out of pressure chamber 122 through conduit 121 and bores 125' and 125. Consequently, auxiliary piston 123 will be forced back by spring 131 to its original position. At the same time, stem 141 on piston 123 moves out of passage 140 whereby the air in pressure chamber 137 above ram piston 102 is released through passage 139, chamber 138, passage 140, and air vent 132 to the outer atmosphere. At the same time, valve disk 135 is forced by spring 133 upon its seat so that the main valve will be closed. The sudden release of the air from pressure chamber 137 then allows ram piston 102 under the action of the stored-up air from chamber 105 to fly back to its original position where it will be arrested by the resilient pin 148.

FIG. 3 illustrates a slight modification of the nailing apparatus in which for additional safety a lever 152 is

provided which may be set so as to prevent trigger 126 from being operated.

The nailing apparatus as illustrated in FIG. 4 corresponds in its main part to the embodiment shown in FIG. 1. The lower part therefore is not shown. So far as the parts shown in FIG. 4 are equal or correspond to parts shown in FIG. 1, they are indicated respectively by the same reference numbers or by new reference numbers, the corresponding part of FIG. 1 being mentioned in brackets after the first occurrence of the new reference number. In accordance with the embodiment shown in FIG. 1, the embodiment illustrated in FIG. 4 consists of a cylinder 301 (101), in which a ram piston 302 (102) is slidable, and a cylinder head 304 (108) which forms a single unit and is screwed upon the upper end of cylinder 301 by means of screw threads 303. The wall of cylinder 301 contains an air inlet conduit 305 (139) through which the compressed air is passed from the inlet valve 135 into pressure chamber 301' of cylinder 301.

Piston 302 carries on its lower end a ram rod 306 (145), the lower end of which (not shown in the drawing) hits upon a nail or the like when piston 302 is propelled downwardly in a similar manner as previously described with respect to FIGS. 1 and 2.

The upper end of the ram piston 302 carries stem 307 (146) which is adapted to pass into a socket 308 (147) in cylinder head 304. The upper end 309 of stem 307 is of a conical shape. Underneath this conical end 309, stem 307 has an annular recess 310 (146') into which two locking bolts 311 (148) are adapted to engage which are disposed diametrically opposite each other so as to insure a symmetrical action upon the conical end 309 when piston 302 returns to its original position. The upper side of recess 310 forms a flat surface 312 which extends substantially at right angles to the longitudinal axis of stem 307.

The inner ends 313 of locking bolts 311 which are adapted to engage into recess 310 are cylindrical so as to cooperate with surface 312 and lock the ram piston 302 when it arrives at the end of its return stroke. The main body 314 of each of bolts 311 is made in the form of a piston which is slidable in a corresponding bore 315 in cylinder head 304 in which a gasket ring 316 is provided so that piston 314 will slide within bore 315 with an airtight fit. At its outer end, each bore 315 has an enlargement 317 which communicates with the outer atmosphere through a bore 317'. Each piston 314 has a central socket-like bore 318 in its outer end in which a compression spring 319 is mounted, the outer end of which is held in a recess in the outer wall 320 of the cylinder head facing toward bore 318. This wall 320 is disposed at such a distance from piston 314 that it may also serve as an outer end stop for limiting the outward movement of the piston and thus prevent the same from being thrown out of its bore 315. Piston 314 also has a flange 321 which is adapted to engage with the outer edge of bore 315 to limit the extent of the inward movement of the piston and of the reduced solid ends 313 thereon which are adapted to engage into recess 310 on stem 307.

If the ram piston 302 after carrying out one impact is propelled backwardly by the air which it had compressed during the nail-driving stroke, as described with reference to FIG. 1, the conical surface 309 on the end of stem 307 will first force locking bolts 311 back into their bores 315 against the action of springs 319 so that stem 307 can penetrate into the socket-like bore 308 until its end engages with the bottom 322 thereof which is preferably provided with a resilient member 323 which acts as a shock absorber. As soon as, during this upward movement of the ram piston, the flat upper edge 312 of the annular recess 310 passes beyond the reduced solid ends 313 of locking bolts 311, springs 319 force these bolts radially inwardly so that the ends 313 engage into recess 310. Since the cylindrical ends 313 of bolts 311 engage with edge 312 which extends at right angles to the axis

of the piston, these ends form a secure lock which prevents piston 302 from dropping downwardly under any conditions. If the air inlet valve 135 is then opened, the compressed air will flow in the direction shown by arrow 324 through the inlet passage 305 into pressure chamber 301' and into bore 308. The air pressure will then force the two pistons 314 of the locking bolts against the action of springs 319 into their bores so that the ends 313 of the bolts will disengage from recess 310 and release stem 307 of the ram piston 302 which the compressed air will then propel downwardly.

In the further modification of the invention, as shown in FIG. 5, all parts which correspond to those shown in FIGS. 1 and 4 are indicated by similar reference numerals, respectively, as those in FIGS. 1 and 4, plus 200. These parts and their function need therefore not be further described. Cylinder head 504, as shown in FIG. 5, consists of a soft metal and preferably a light metal. For this reason, the annular recess 540 in the lower end of cylinder head 504 is provided with a bushing 541 of a harder metal with inner screw threads which are screwed upon the outer screw threads 503 on the upper end of cylinder 501. Bushing 541 is held within recess 540 by means of at least one setscrew 542. Bore 508 in cylinder head 504 is likewise provided with a hardened bushing 543 for guiding the head 509 of piston stem 507. This head 509 has an outer surface of a substantially parabolic longitudinal sectional shape whereby, at a substantially constant return speed of the ram piston 502, the locking bolt 511 which is guided within a bushing 544 will be forced by this surface at a constant rate of acceleration in a radially outward direction. Such constant acceleration has the advantage that the backwardly moving surface of head 509 of the piston stem will be subjected at each respective point of engagement between head 509 and the end 513 of the locking bolt to the same pressure, and that this surface 509 as well as the end 513 of the locking bolt will therefore be worn to the least possible extent.

In order to prevent the end 513 of the locking bolt from being worn by the impact thereon of surface 512, this part of the bolt end 513 facing toward the lower end of head 509 is preferably provided with a flat portion 513'. The proper position of this flat surface 513' parallel to surface 512 will always be insured when the locking bolt is being inserted by providing the latter with suitable guiding means which may, for example, consist of a pin 545 which is fitted into bushing 544 and engages into a groove 546 in flange 521 on the outer end of bolt 511. The bolt retaining wall 520 according to FIG. 5 is formed of a cap screw 547 with outer threads 548 which may be screwed into a corresponding bore in cylinder head 504.

The operation of the apparatus as illustrated in FIG. 5 substantially corresponds to that described with respect to FIG. 4, except that, due to the special design of head 509, locking bolt 511 will be forced radially outwardly at a constant rate of acceleration during the return stroke of piston 502, and that, when the piston rebounds from the resilient member 523, surface 512 will hit upon the flat portion 513' on the bolt end 513, whereby the respective parts will be protected almost entirely from any wear.

Although our invention has been illustrated and described with reference to the preferred embodiments thereof, we wish to have it understood that it is in no way limited to the details of such embodiments, but is capable of numerous modifications within the scope of the appended claims.

Having thus fully disclosed our invention, what we claim is:

1. An apparatus operated by compressed air for driving nails or the like into a wall or other object, comprising a main cylinder, means connected to said cylinder for holding and guiding a nail or the like, a ram piston slidable within said cylinder under the action of the

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compressed air upon one side of said piston to define a working stroke and adapted to hit upon said nail, means for returning said piston after completing said working stroke, a main air inlet valve for admitting the compressed air into said main cylinder, an auxiliary valve having a cylinder and a piston slidable therein for operating said main valve, a second auxiliary valve having a cylinder and a piston slidable therein for operating said first auxiliary valve, and means for manually operating said second auxiliary valve.

2. An apparatus as defined in claim 1, wherein said means for returning said piston after completing its working stroke comprise an air storage chamber concentrically surrounding at least a part of said main cylinder, the wall of said cylinder having at least one aperture communicating with said air storage chamber at the other side of said piston at a point near the end of the working stroke thereof, said chamber storing the air forced out of said cylinder by said piston during said working stroke and holding said air in a compressed condition.

3. An apparatus as defined in claim 1, further comprising an air inlet passage, said second auxiliary valve adapted to control said air inlet passage, said cylinder of said first auxiliary valve communicating at one side of the piston thereof with said air inlet passage and at the other side with the outer atmosphere and with the pressure chamber of said main cylinder at one side of said ram piston through a passage connecting said first auxiliary valve with said pressure chamber, and means on said first auxiliary valve piston adapted to pass through said passage to act upon said main inlet valve to open the same, said passage being adapted to be closed tightly by said means when said first auxiliary valve is operated.

4. An apparatus as defined in claim 1, further comprising a cylinder foot connected to one end of said main cylinder, a main air inlet adapted to be connected to a compressed air line, said second auxiliary valve and said main air inlet being mounted on said cylinder foot, and a cylinder head connected to the other end of said main cylinder, said main air inlet valve and said first auxiliary valve being mounted on said cylinder head.

5. An apparatus as defined in claim 1, further comprising an air inlet passage, said main valve communicating at one side with said inlet passage and at the other side with the pressure chamber of said main cylinder, said cylinder of said second auxiliary valve communicating at one side of the piston thereof with said air inlet passage and at the other side with said cylinder of said first auxiliary valve at one side of the piston thereof, said cylinder of said first auxiliary valve having at the other side of said piston thereof a passage leading to the outer atmosphere and a second passage leading to said main valve and to said pressure chamber of said main cylinder, a stem on said first auxiliary valve piston adapted to pass with a close fit through said second passage to act upon said main valve to open the same when said second auxiliary valve is opened by said manually operated means, and also to close said second passage tightly relative to said first passage.

6. An apparatus as defined in claim 5, further comprising a nozzle slidably mounted at the end of said main cylinder opposite to said pressure chamber, a spring for normally maintaining said nozzle in an extended position spaced from said main cylinder, said nozzle having a portion thereon adapted to engage with said manually operated means to maintain the same in an inoperative position when said nozzle is in said extended position and to disengage from said manually operated means when said apparatus is pressed with said nozzle against an object to permit said means to be manually operated.

7. An apparatus as defined in claim 5, further comprising a stem on said second auxiliary valve piston slidably mounted with a close fit within the housing of said second auxiliary valve and extending to the outside thereof, said stem having a bore therein forming a passage

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from the other side of said second auxiliary piston cylinder to the outer atmosphere when said manually operated means are released and said second auxiliary valve is closed, said manually operated means comprising a lever, means for pivotably mounting said lever, one end of said lever adapted to engage with the outer opening of said bore to close the same when the other end of said lever is pivoted manually.

8. An apparatus as defined in claim 7, wherein said manually operated means comprises a trigger and a two-armed lever, a resilient member mounted on the end of one arm of said lever, said trigger when pulled acting upon the other arm of said lever to pivot said lever and press said resilient member upon the outer opening of said bore to close the same tightly.

9. An apparatus as defined in claim 1, further comprising a cylinder head connected to said main cylinder, a recess in said piston, a locking bolt slidably mounted in said cylinder head to engage said recess, an air passage connecting said main inlet valve to said second auxiliary valve, the rear side of said locking bolt being positioned within said last-mentioned air passage to be acted upon by the compressed air within said air passage for normally maintaining said locking bolt in an inward position to engage said piston.

10. In an apparatus operated by compressed air for driving nails comprising three concentric cylinders, a cylinder head and a cylinder foot connected to opposite ends of said cylinders to co-operate with said cylinders to define a pressure chamber with the innermost cylinder, means for holding and guiding a nail near one end of the innermost cylinder, a ram piston slidably mounted within the innermost cylinder and adapted to hit said nail upon the action of the compressed air, means for feeding compressed air to the interior of the outermost cylinder, means for feeding compressed air from the outermost cylinder to the innermost cylinder at one side of said piston, means including the intermediate and innermost cylinders for defining an air storage chamber for returning said piston after completing its working stroke, said ram piston having a recess therein near its rear end and releasable locking means for locking said piston in a fixed position at a point near the end of its return stroke, said locking means comprising at least one locking bolt slidably mounted in said cylinder head, means for maintaining one end of said bolt within said recess as long as the rear side of said ram piston is not acted upon by the compressed air in said pressure chamber, which bolt is exposed to the compressed air within said chamber, whereby said bolt is forced outwardly by said compressed air within said pressure chamber acting directly on said bolt to disengage said bolt from said recess.

11. An apparatus as defined in claim 10 wherein the recess in the rear end of said piston for receiving said locking bolt is defined at one end facing toward said end by a flat surface extending substantially vertically to the axis of said cylinder, said bolt end being substantially cylindrical, the rear end of said piston terminating into a substantially conical surface adapted to force said locking bolt outwardly near the end of the return stroke of said piston.

12. An apparatus as defined in claim 10, wherein the outer surface of the rear end of said ram piston has a shape substantially corresponding to a paraboloid of revolution for engaging with and pressing said locking bolt outwardly near the end of the return stroke of said piston.

13. An apparatus as defined in claim 10, wherein said end of said locking bolt which is adapted to engage into said recess in said ram piston has a flat portion facing toward the rear end of said piston when said locking bolt engages into said recess, said flat portion extending parallel to said flat surface defining the rear side of said recess.

14. An apparatus as defined in claim 13, further com-

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prising means for preventing said locking bolt from turning about its axis.

15. In an apparatus operated by compressed air for driving nails or the like into a wall or other object having a cylinder, means connected to said cylinder for holding and guiding a nail or the like, resilient means for preventing said nail from entering into said cylinder, resilient means for preventing said nail from falling out of said guiding means on said cylinder and thus from said apparatus, a ram piston slidable within said cylinder under the action of the compressed air upon one side of said piston and adapted to hit upon said nail within said guiding means, an air inlet valve for admitting the compressed air into said main cylinder, means for returning said piston after completing its working stroke,

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and releasable means for locking said piston in a fixed position at a point near the end of its return stroke.

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