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COMPRESSED AIR-OPERATED APPARATUS TO DRIVE IN STAPLES, NAILS OR OTHER FASTENERS IN WORKPIECES

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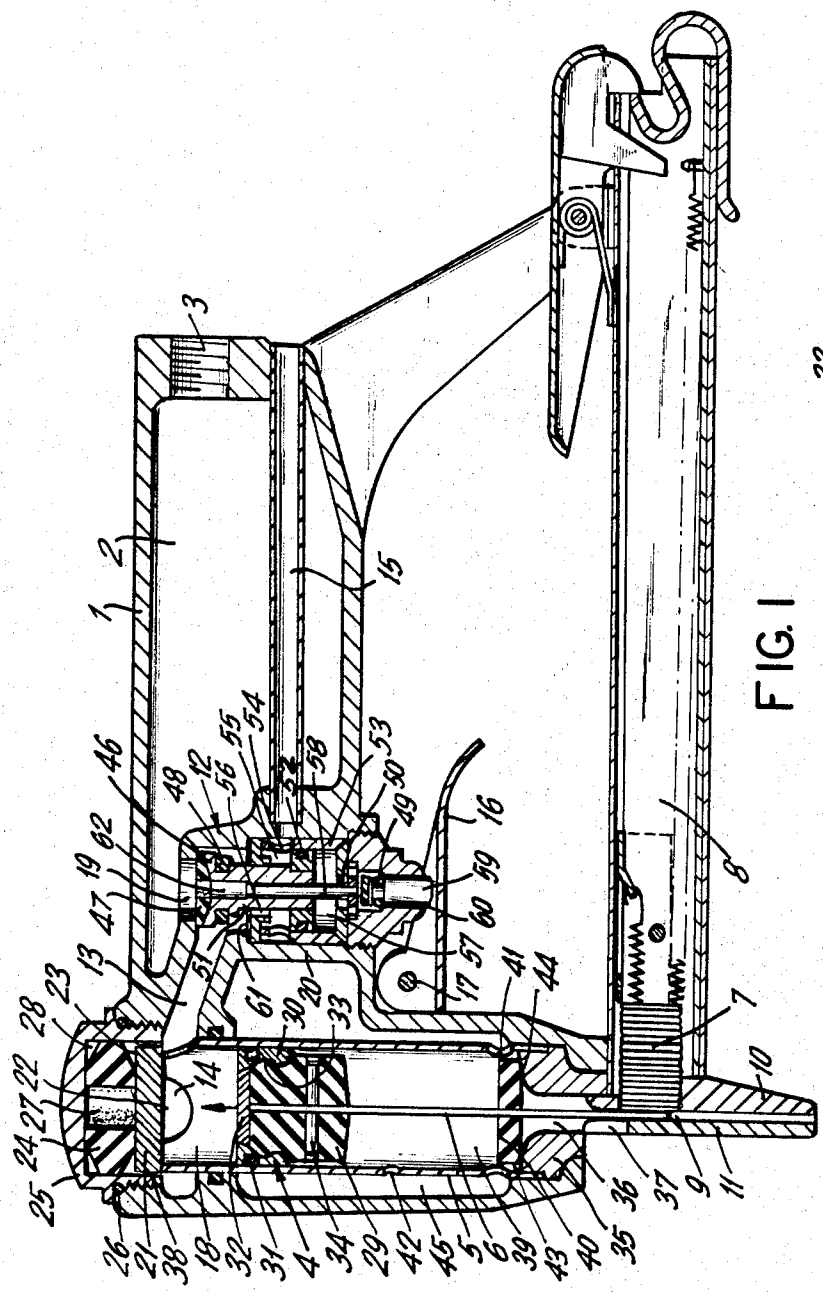


FIG. 1

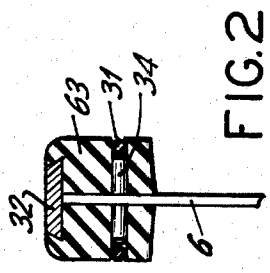


FIG. 2

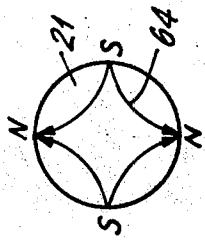


FIG. 3

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COMPRESSED AIR-OPERATED APPARATUS TO DRIVE IN STAPLES, NAILS OR OTHER FASTENERS IN WORKPIECES

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14 Claims. (Cl. 91—461)

ABSTRACT OF THE DISCLOSURE

A compressed air driver for staples, nails or other fasteners, in which a permanent magnet holds back the piston in a cylinder until compressed air flowing to the cylinder builds up sufficient force to overcome the magnet, said magnet being transversely polarized with the poles lying within the face of the magnet facing the piston, with the magnet elastically supported by an upper buffer in a direction axially of the cylinder, with a magnet in the piston facing the permanent magnet, with a cap backing up the upper buffer, and the cylinder comprising a cylindrical bushing clamped between the upper buffer and a resilient lower buffer.

Brief summary of the invention

This invention relates to a compressed air-operated apparatus to drive in staples, nails or other fasteners in workpieces, said apparatus being provided with a permanent magnet associated with the piston effective on the drive-in ram, said permanent magnet keeping the piston in its starting position at the beginning of the working step, until the increasing pressure of the compressed air flowing into the cylinder at the opening of the control valve and biasing the rear side of the piston overcomes the retaining force of the permanent magnet. In this manner, the result is that the piston commences its drive-in stroke only after the full pressure of the compressed air has been built up above the piston. This is especially important because the driving in of the fastening element is effected by one single stroke which must be performed with a correspondingly great amount of kinetic energy. In addition, the piston is to be retained in its uppermost position in order to prevent it from sliding backwards an amount corresponding to the distance through which the ram being in the retracted position is spaced from the stack of staples which would result with a loss of kinetic energy by shortening the stroke.

The known permanent magnets used for this purpose are polarized in the axial direction of the cylinder, the surface of the permanent magnet facing towards the piston being formed either as the north pole or as the south pole. During assembly of the magnets, care must be taken at all events that the magnetic flow is closed within the retaining means of the permanent magnet. In addition, the scattering factor, i.e. the proportion of the total flow to the useful flow reduced by the scattering flow outside the air gap, is to be kept as low as possible. Under these circumstances, it has become general practice to enclose these magnets polarized in an axial direction in a sleeve (spacer sleeve) of non-ferromagnetic material (generally a brass ring) and to fit this sleeve in turn in a cup of ferromagnetic material in particular soft iron for the formation of a return flow and screening coating, said cup comprising a bottom and being retained by a closure cap closing the cylinder upwardly. Also the closure cap consists suitably of ferromagnetic material in order to secure a closure of the magnetic flow possibly free from scattering effects. Also annularly shaped permanent magnets have already become known for the same purpose. These annular permanent magnets are likewise polarized in an axial direction.

In any case, with these known permanent magents a careful machining of both the permanent magnet and the socket thereof is necessary so that the production and the fitting of these permanent magnets becomes rather costly. In addition, the hard blow by which the piston strikes against the permanent magnet at the end of its stroke, cannot be dampened, because the permanent magnet must be embedded in a socket of ferromagnetic material, especially soft iron, for reasons connected with magnetism. As a result of these hard strokes permanent breakages may occur in the housing, namely at that point where the compressed air is introduced into the cylinder.

This invention is concerned with the problem of providing an apparatus with a permanent magnet of the type described which may be fitted at low cost and the magnetic flow of which closes with a low scattering factor above the cylinder space or the piston, respectively, whereby a far reaching independency is reached as regards the design of the socket of the permanent magnet. The solution to this problem is to be especially improved in that a possibility is provided for a resilient-elastic bearing of the permanent magnet.

In accordance with this invention, the problem is solved in that the permanent magnet is formed as a transversely polarized magnet, in particular formed as a disc, the poles of which are disposed within its disc face facing towards the piston. The poles of the magnet thus lie in the disc surface side by side or diametrically opposite each other, respectively. As a rule, it will suffice to polarize the magnet only with two poles within the disc surface. In this case, the disc may be magnetized diametrically, in which the north pole and the south pole which are disposed diametrically opposite each other in the magnet disc surface facing towards the working piston, may extend also along the periphery of the disc. However, it is also possible within the boundaries of the invention to employ a doubly polarized disc magnet. In this case, in particular, a lateral polarization is employed, in that the poles of for instance two pairs of poles are disposed side by side in the surface of the magnetic disc facing towards the working piston, namely either in the sequence (counted in the directon of the periphery) NSNA or also, although less favourable, in the sequence NNSS.

For the realization of the invention, ceramic magnetic materials on the basis of ferrites are particularly suited such as are marketed by the firm Phillips for instance under the protected trademark "Ferroxdure" or by the Deutsche Edelstahlwerke under the protected trademark "Oxit." Such ferrites or ceramic magnetic materials are remarkable for their extremely high coercitive field strength of about 1400 to 1600 oersted and thereabove, and are very well suited for transversely polarized magnets, the poles of which are disposed in one plane because the poles disposed side by side and opposing each other are not weakening each other in a degree worth mentioning. The remanence of such ceramic magnetic materials is about 2200 gauss and thereabove. The transversely polarized permanent magnet used in the invention must still be ground at its disc faces, it is true, but it is no longer necessary to fit the cylindrical peripheral surfaces thereof into the socket so that the work and coat connected with the machining and fitting of the permanent magnet are considerably reduced. As a result of the very high coercitive field strength and the relatively low remanence of such ceramic magnetic materials, there results just for them, with a suitable selection of the work-

ing point, a short but broad construction, that means a relatively flat disc, which has a favourable effect on the subject matter of the application. Other permanent magnet materials of high coercitive field strength, such as for instance AlNiCo or AlNiCoTi magnetic materials (Oerstit of the Deutsche Edelstahlwerke, Reco and Ticonol of Philips, Koerzit of Krupp (also ferrites), Parmanit of Bohler), are however likewise suitable for the realization of the invention.

As now, without having to take into the bargain an unfavourable scattering factor, the socket of the permanent magnet need no longer secure the closing of the magnetic flow, in accordance with the invention, the disc-shaped transversely polarized permanent magnet is resiliently elastically supported in an axial direction in the cylinder. This resiliently elastic support is obtained, in particular, by means of a buffer ring of elastomeric material (for instance of Desmophen in combination with Desmodur (Vulkollan), which is arranged above the permanent magnet and provided with relief openings. The relief openings in this arrangement are serving the purpose of securing a deviation of the elastic material as soon as the piston strikes against the permanent magnet supported by the buffer ring. Because of the fact that the polarized permanent magnet is resiliently elastically supported, it need no longer be feared that permanent breaks will occur in the housing as a result of the constantly repeating hard blows of the piston on the permanent magnet.

The subject matter of the invention is furthermore improved by the feature that the cylinder running bushing is supported between the permanent magnet and a resiliently elastic lower buffer insert consisting preferably likewise of elastomeric material, and that the cylinder running bushing together with the permanent magnet and the upper and lower buffer insert may be clamped tight by means of a closure cap closing the cylinder.

In this manner there results an especially simple assembly of the piston including the cylinder and an especially effective dampening of the piston movement both at the end of the working stroke and at the end of the return stroke.

Suitably, in the case of the subject matter of the invention, the closure cap consists of a non-ferromagnetic material, especially of aluminium or a light metal alloy. The piston, too, suitably consists of aluminium or a light metal alloy having only a ferromagnetic bonnet or insert facing towards the permanent magnet.

The cylinder running bushing suitably consists likewise of aluminium or a light metal alloy and is provided with a hardened, in particular, coated running surface. This design contributes to concentrate the magnetic flow of the transversely polarized permanent magnet to the region in which the working piston is situated.

Other objects of this invention will in part be obvious and in part hereinafter pointed out.

The invention accordingly consists in the features of construction, combinations of elements, and arrangement of parts which will be exemplified in the construction hereinafter described, and of which the scope of invention will be indicated in the following claims.

Brief description of several views of the drawing

In the accompanying drawing, in which is shown an illustrative embodiment of this invention,

FIG. 1 is a longitudinal sectional view of the compressed air nailing apparatus designed in accordance with the invention;

FIG. 2 is a partial sectional view of another embodiment of the working piston for the compressed air nailing apparatus of FIG. 1; and

FIG. 3 is a view taken on the face of the permanent magnet directed towards the piston with the two pairs of poles shown in a diagrammatic arrangement.

Detailed description of the invention

In accordance with FIG. 1, the compressed air nailing apparatus is provided with a housing **1** having a compressed air reservoir **2** constantly communicating with a source of compressed air via a connection **3**. A working piston generally designated by **4** is also arranged in the housing **1** which may be axially displaced by means of a cylinder bushing **5**.

The working piston **4** drives a ram **6** in a manner known per se, said ram serving to drive staples, nails or the like **7** into a workpiece (not shown). The compressed air staples or nails **7** are arranged in a magazine **8** and are supplied to the ram guiding channel **9** which consists of the two parts **10** and **11** and is arranged at the lower end of the housing **1**. The magazine **8**, besides, may be designed in any suitable manner known per se and therefore, is not described in more detail.

In the housing **1**, there is also arranged a manually operated control valve which is generally designated by numeral **12** and which communicates with the upper end of the cylinder bushing **5** via a control channel **13**. This cylinder bushing is provided at its upper end with large recesses or windows **14**, via which the interior of the cylinder bushing **5** is in communication with the control channel **13**.

The manually operated control valve **12** is also connected with the outer atmosphere via a line **15** extended through the compressed air reservoir **2**. The manually operated control valve **12** is operated by means of a trigger arm **16** which is rotatably pivotable about a journal **17** against the effect of the release pin **59** biased with compressed air. It is possible by actuation of the trigger arm **16** and with the aid of the control valve **12** to connect the control channel **13** and thus the upper working space **18** of the cylinder **5** either with the atmosphere via the line **15** or with the compressed air reservoir **2** via the opening **19** of the control valve housing **20**.

The cylinder bushing **5** merges in a reservoir **45** which is separated from the compressed air reservoir **2** by the control valve housing **20**.

In accordance with the invention, a disc-shaped permanent magnet **21** abuts the upper edge of the cylinder bushing, the magnetic material of which has an especially high coercitive field strength and consists of a ferrite or some other ceramic sinter metal. Said magnet is transversely, i.e. laterally or diametrically, polarized in such a manner that the poles lie in the surface **22** which faces towards the working piston **4**. One prefers an embodiment in which two north poles and two south poles are disposed within this area **22**, i.e. two pairs of poles. The other side **23** of the transversely polarized permanent magnet is supported on a screw cap **25** via a buffer **24**, said screw cap being screwed into the housing **1** with the aid of a sealing **26**, in this way closing the cylinder including the control channel **13** upwardly. The buffer **24** is provided with a central discharge opening **27** and relief openings **28** arranged on the periphery which makes possible, in particular, an escape also of the buffer material if compressed under the influence of a compression force.

The screw cap **25** is preferably made of a non-ferromagnetic material for instance a light metal alloy, because this screw cap need not close the magnetic flow of the transversely polarized permanent magnet **21**, same as is the case with the buffer **24**.

The working piston **4** of FIG. 1 comprises a basic member **29** of elastomeric material, for instance, a material marketed under the protected trademark Vulkollan. The upper peripheral edge of this basic member **29** is armoured with a ring **30** which, for instance, may consist likewise of a light metal alloy or also of a ferritic material, in particular steel. Within said ring **30** carrying the piston sealing **31**, there is arranged, for

instance, by means of a conical fitting, a disc 32 of ferromagnetic material, especially soft iron, which serves to cooperate with the poles of the transversely polarized permanent magnet 21. To improve the connection of the peripheral ring 30 with the basic member 29, the peripheral ring 30 is provided with a restriction or groove 33 having a corresponding peripheral boss of the basic member engaging therein.

The design of the upper side of the working piston 4 and the selection of the materials for the ring 30 and the disc 32 are dependent also on the position of the poles on the pole face 22 of the permanent magnet 21.

The ram 6 is pivotally connected at the basic member 29 with some clearance with the aid of a journal or pin 34 supported in a bore of the basic member, such that the upper edge of the ram 6 is supported on the lower edge of the covering plate 32.

The cylinder bushing is supported on a lower buffer 35 by its lower edge, said buffer being arranged in the housing 1 and comprising a center passage opening 36 through which the ram 6 extends, too. The center opening of the buffer 36 is connected with the atmosphere via an exit channel 37.

The bottom buffer 35, cylinder bushing 5, the permanent magnet 21 and the buffer 24 thus are retained in position with the aid of the screw cap 25, the parts being assembled one after the other and taking abutment one on the other. In this arrangement, there my be a certain play 38 between the periphery of the permanent magnet 21 and the screw cap 25.

On the ram 6 there is provided for loose displacement within the lower space (return space) 39 of the cylinder 5, a valve disc 40 preferably consisting of elastomeric material. Between the outer periphery of the valve disc 40 and the bore of the cylinder bushing 5, there is provided an annular space 43 through which the air may flow from the return space 39 during the working stroke of the working piston 4. The cylinder bushing 5 comprises a plurality of relatively larger passage openings 41 at its lower end and, in addition, is provided with one or several smaller passage bores 42 respectively, at a level to be just in communication with the upper working space 18 when the working piston is in its lower dead center position. The openings 42 at this moment establish a restricted connection between the working space 18 and a reservoir 45 separated from the compressed air reservoir 2.

In the upper dead center position, the working piston 4 is retained by the permanent magnet, with the magnetic flow of the transversely polarized permanent magnet closing over the ferromagnetic plate 32 of the piston 4. The control channel 13 is connected with the compressed air reservoir 2 by means of the control valve 12. The piston is retained in its upper dead center position until the force exerted thereon by means of compressed air overcomes the force exerted by the permanent magnet. The piston then starts its driving stroke with considerable acceleration. Under certain circumstances, the upper side of the piston may be provided with grooves or recesses in order to facilitate the initiation of effectiveness of the compressed air on the upper side of the piston.

During this downward stroke, the air present in the return space 39 flows through the annular gap all around the valve disc 40 into the central opening 36 and from there into the open through the channel 37. The valve disc in this arrangement is incapable of abutting its seat 44 formed by the lower buffer 35. The piston thus may exert its working stroke with a high speed without compressing any air on its underside.

In the lower dead center position, however, the valve disc 24 is pressed onto its seat 44 by the piston 4 so that the lower working space 4 no longer has any communication with the atmosphere.

The upper side of the piston has almost simultaneously established the connection between the reservoir 45 and

the upper working space 18 through the throttled opening 42. The compressed air from the working space 18 which at this moment is still connected with the compressed air reservoir, now flows through the openings 42 into the reservoir 45 and biases the working piston 44 from below, said working piston 44 biasing the lower buffer 35 and the valve disc 40 after having reached its lower dead center position. The valve disc in this arrangement keeps the outlet opening 36 closed, the piston being biased at the same time from below by compressed air via the line 41, and safely returned into its starting position. At the end of the return stroke, the pressure in the return space 39 has been reduced to a sufficient extent such that the valve disc 40 may lift from its seat 44. This opening movement is enhanced by the friction between the valve disc 40 and the upwardly moving ram 6.

The control valve 12 consists of a main control valve 46 with the two valve discs 47 and 48 and a pilot control valve 49 cooperating with a control bushing 50. The two valve discs 46 and 47 of the main control valve are arranged on a main control valve body 51 having a piston 52 fastened thereto, the effective area of said piston being greater than that of the valve disc 46 controlling the compressed air supply opening 19. The piston 52 is arranged for axial displacement in a control bushing 53 provided with windows 54 connecting a center control space 55 with the outer opening 15. The control space 55 is connected with the control channel 13 via a channel 56.

The lower working channel 57 of the control piston 52 in the position as shown in FIG. 1 is communicating with the compressed air reservoir 2 via an opening 58 provided in the bushing 50 and a bore 62 in the main control member 51. In this manner, the control piston 52 is pressed into its upper position in which the main control valve disc 46 closes the compressed air supply opening 19 so that now the control channel 13 communicates with the relief line 15 via the opening 56 and the windows 54.

When the compressed air-nailing apparatus is to be actuated, the operator presses the pilot control valve 49 upwardly by means of the trigger arm 16 and a ram 59 whereby the bore 58 in the valve ram is closed and simultaneously the working space 57 is communicated with the atmosphere via a channel 60 controlled by the ram 59. The compressed air in the compressed air reservoir now presses the main valve body 46 downwardly so that now the upper side of the working piston is biased with compressed air. Simultaneously, the valve member 46 abuts the associated valve surface 61 and thereby blocks the control channel 13 from the relief opening 15.

The embodiment in accordance with FIG. 2 differs from that one according to FIG. 1 only in that the peripheral ring has been omitted from the working piston 4. The working piston thus consists here of a basic member 63 of elastomeric material such as Vulkollan on the upper side of which a closure disc 32 of ferromagnetic material is laid-in. The upper edge of the ram 6 again abuts the lower edge of the said soft iron plate. The ram 6 is in addition pivotally connected with the basic member via a journal 34. Here, the piston seal 31 is arranged in the region of the pin or journal 34.

FIG. 3 shows an elevational view taken on the surface 21 of the permanent magnet 21 with two pairs of poles polarized in this area, the magnetic flow of which from the south poles S to the north poles N is indicated by the curved lines 64.

It will thus be seen that there is provided an article in which the several objects of this invention are achieved, and which is well adapted to meet the conditions of practical use.

As possible embodiments might be made of the above invention, and as various changes might be made in the embodiment above set forth, it is to be understood that all matter herein set forth or shown in the accompanying

drawings, is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. Compressed air operated apparatus to drive in staples, nails or other fasteners into workpieces, comprising a housing, means in said housing to provide a cylindrical bore, a piston slidable in said bore, a ram attached to said piston, means including a control valve to cause compressed air to flow to the cylinder to cause movement of said piston for a working operation, a permanent magnet associated with said piston to retain the piston in starting position at the beginning of the working operation until the increased pressure of compressed air flowing into the cylinder, when the control valve is actuated and biasing the upper side of the piston, overcomes the retaining force of the permanent magnet and moves said piston in one axial direction in said bore, said permanent magnet being transversely polarized with the poles lying within its face facing toward the piston.

2. The combination of claim 1, and means to resiliently support said magnet against movement in an opposite axial direction.

3. The combination of claim 2, said means to resiliently support said magnet, comprising a buffer member of elastomeric material arranged above the permanent magnet.

4. The combination of claim 3, said buffer member having a relief opening.

5. The combination of claim 1, said means providing a cylindrical bore comprising a cylindrical bushing within said housing, said piston being disposed within said bushing, the upper end of said bushing abutting said permanent magnet and a resilient lower buffer in the housing abutting the lower end of said bushing.

6. The combination of claim 5, and means on the housing to clamp said bushing between said magnet and lower buffer.

7. The combination of claim 6, said clamp means comprising a closure cap on said housing, and a resilient buffer member interposed between said magnet and cap.

8. The combination of claim 7, said resilient buffer member interposed between said magnet and cap comprising a ring of elastomeric material.

9. The combination of claim 7, said closure cap comprising non-ferromagnetic material.

10. The combination of claim 9, said material of which the closure cap is made comprising lightweight metal.

11. The combination of claim 1, said piston comprising a member made of non-ferromagnetic material, and a ferromagnetic member attached to said non-ferromagnetic member and facing toward said permanent magnet.

12. The combination of claim 11, wherein said non-ferromagnetic material comprises one of the group consisting of elastomeric material, aluminium and light metal alloy.

13. The combination of claim 5, said bushing comprising a lightweight metal provided with a hardened inner surface.

14. The combination of claim 5, said bushing comprising a lightweight metal having a coated inner surface.

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