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(54) Improvements in or relating to pneumatic tools.

(57) A pneumatic reciprocating tool comprises a cylinder body (12) and an air-operated piston (110) which reciprocates within said cylinder body during sustained use of said tool, air being exhausted from an exhaust port (24) in said cylinder body during such use. The pneumatic tool includes a silencer arrangement (126) substantially totally surrounding said cylinder body and formed of a length of metallic structural hollow section. Mounting means (128), (130) for mounting said silencer arrangement on said pneumatic tool are also provided and optionally include a vibration reducing arrangement.

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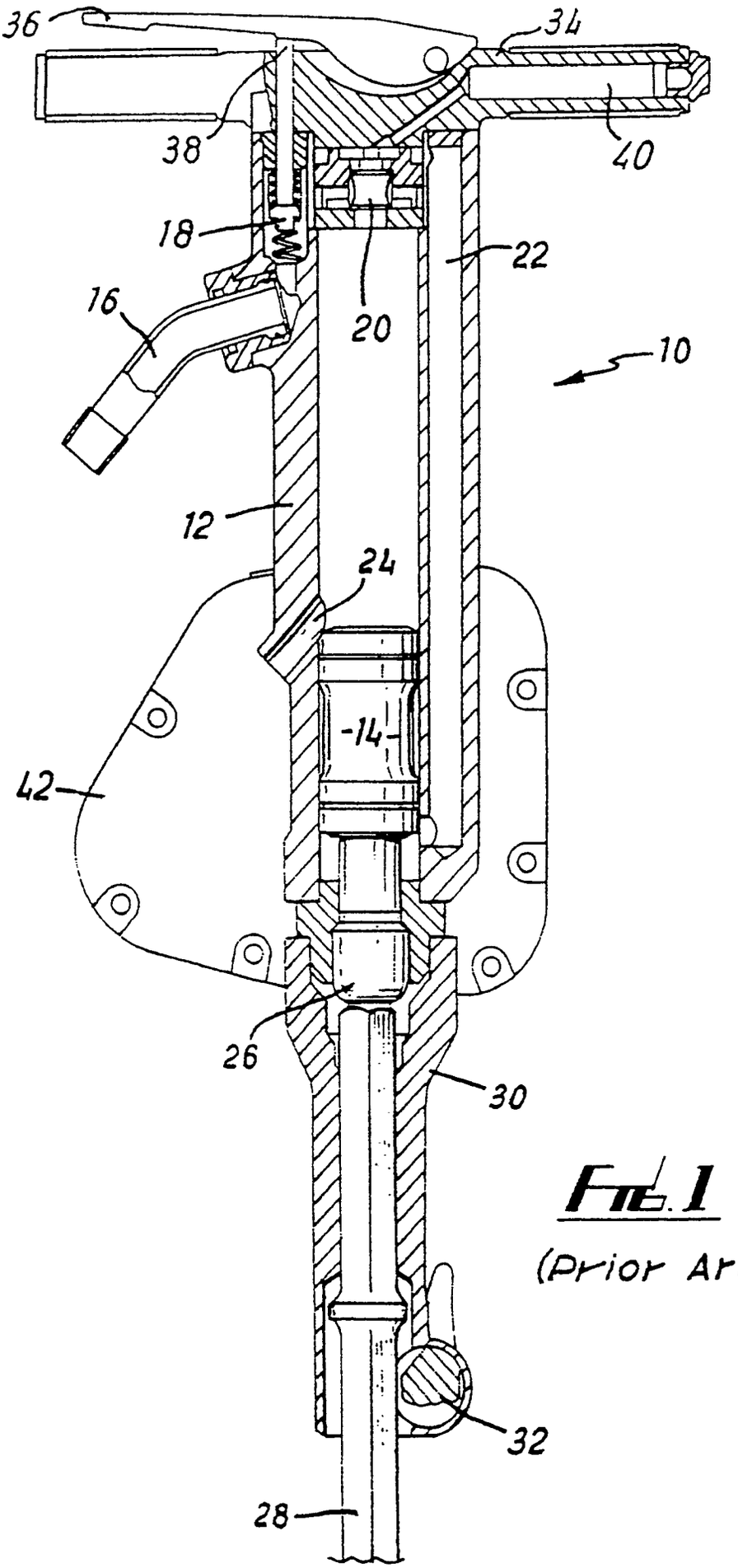

FIG. 1
(Prior Art)

IMPROVEMENTS IN OR RELATING TO PNEUMATIC TOOLS

This invention relates to pneumatic tools, and more particularly but not exclusively to the silencing and/or vibration damping of pneumatic tools.

Pneumatic tools are powered by compressed gas, the gas usually but not necessarily being air. In this specification, references to "air" and to "air tools" are to be taken (unless the context prohibits) as references respectively to gases in general and to pneumatic tools in general.

Reciprocating air tool such as paving breakers, hammers, rivetters, and the like conventionally include a metal cylinder body and an air-operated piston which reciprocates within the cylinder body during sustained use of the tool. The cylinder body has an exhaust port (or a group of exhaust ports) through which used air is exhausted during use of the tool. The piston shuttles back and forth within the cylinder, and it is arranged that at or near one end of its travel, the kinetic energy of the piston is abruptly transferred to an axially mobile tool bit, for example a chisel or a spade.

Such reciprocating air tools are notoriously noisy, not least due to the highly impulsive exhaustion of used air into the ambient environment. Unsurprisingly, proposals have been made for the silencing of reciprocating air tools, generally in the form of a casing clamped around the tool body. One such clamp-on silencer casing is illustrated in Fig 1 of the accompanying drawing, and detailed below. This known form of silencer is fabricated of plastics material, and while adding relatively little to the gross weight of the tool, suffers from certain disadvantages ; the plastics casing is less robust than the basic tool and is easily damaged by the rough handling such tools frequently receive. Further, the plastics material is susceptible to heat damage and degradation by temperature fluctuations and extremes.

A further problem with reciprocating air tools is their inherently high levels of vibration, which can lead to operator fatigue in the short term and to his physiological disfunctionalism in the longer term. Again, proposals have been made for vibration reduction, but the relevant arrangements tend to be complex and susceptible to damage in normal use of the tool.

Moreover, silencing arrangements and vibration reduction arrangements (where also adopted) for reciprocating air tools generally require specially shaped and fabricated components, thus incurring significant extra cost, particularly if they are to be made resistant to dirt, debris and damage.

It is therefore an object of the invention to provide a pneumatic reciprocating tool having a silencer arrangement which is inherently simple in form, and which also forms a protective housing for an optional vibration reduction arrangement.

According to the present invention there is provided a pneumatic reciprocating tool comprising a cylinder body and an air-operated piston which reciprocates within said cylinder body during sustained use of said tool, air being exhausted from an exhaust port in said cylinder body during such use, said pneumatic tool further comprising a silencer arrangement substantially totally surrounding said cylinder body, including said exhaust port therein, said silencer arrangement comprising a length of metallic structural hollow section whose longitudinal axis is generally parallel to the longitudinal axis of said cylinder body, and mounting means for mounting said silencer arrangement on said pneumatic tool.

Metallic structural hollow section is a standard engineering material, usually of steel, with a uniform cross-section which is square or rectangular but may alternatively have some other shape such as circular or elliptical. As such, structural hollow section is an economic material in comparison to specially made metal castings or forgings while having inherent strength, impact resistance and temperature resistance.

Further, a pneumatic tool in accordance with the invention and having a silencer arrangement comprising a length of metallic structural hollow section inherently provides a protective casing for an optional vibration reducing arrangement linking the cylinder body to the remainder of the tool, such that the vibration reducing arrangement (when provided) need only be designed for its vibration reducing function without also having to be inherently resistant to dirt, debris, and impacts.

Moreover, a pneumatic tool in accordance with the invention and having a silencer arrangement comprising a length of metallic structural hollow section inherently provides a protective casing for the cylinder body itself (whether or not the optional vibration reducing arrangement is provided), thus enabling the cylinder body and any associated pneumatic conduit system to be fabricated of plain metal tubing in contrast to the usual specially shaped metal castings or forgings which are relatively expensive in comparison to equivalent lengths of plain tubing. Therefore the present invention enables a pneumatic reciprocating tool to be fabricated of relatively inexpensive standard engineering materials without compromising the necessary robustness and damage resistance of such tools.

Said mounting means for mounting said silencer arrangement on said pneumatic tool may comprise a pair of plates mutually spaced apart along the longitudinal axis of said length of structural hollow section, one of said plates being secured to said length of

structural hollow section and the other of said plates being unsecured to said length of structural hollow section and loosely fitting therein while being substantially rigidly secured to said cylinder body (or substantially rigidly secured to a component or components themselves rigidly secured to said cylinder body), the one of said plates which is secured to said length of structural hollow section being either rigidly secured to said cylinder body (or rigidly secured to a tool component or components themselves rigidly secured to said cylinder body) or being resiliently linked through a resilient vibration reducing means to said cylinder body (or resiliently linked through a resilient vibration reducing means to a tool component or components themselves rigidly secured to said cylinder body). Where one said plate is resiliently linked as aforesaid, the other said plate may be rollingly coupled by a roller system thereon to the inner surface of the said length of structural hollow section such as to permit movement of the other said plate and of the cylinder body along the longitudinal axis of said length of structural hollow section while substantially preventing rotation of said other plate and of the cylinder body about the longitudinal axis of said length of structural hollow section such that tool-turning forces applied by a tool operator to a tool handle directly or indirectly secured to said length of structural hollow section are transmitted to said cylinder body and to a tool bit rotationally secured thereto despite the resilient linking of the one said plate and of the length of structural hollow section secured thereto with the cylinder body through said resilient vibration reducing means.

Embodiments of the invention will now be described by way of example, with reference to the accompanying drawings wherein :-

Fig 1 is a sectional elevation of a known form of paving breaker including a plastics-cased silencer ;

Fig 2 is an incomplete sectional elevation of a first embodiment of pneumatic tool in accordance with the invention ;

Fig 3 is a horizontal section of the first embodiment, taken on the line III-III in Fig 2 ;

Fig 4 is a schematic sectional elevation of a second embodiment of pneumatic tool in accordance with the invention ;

Fig 5 is an incomplete sectional elevation of a third embodiment of pneumatic tool in accordance with the invention ;

Fig 6 is a schematic sectional side elevation (partly in ghost outline) of a fourth embodiment of pneumatic tool in accordance with the invention ;

Fig 7 is a front elevation of the fourth embodiment ;

Fig 8 is a horizontal section of the fourth embodiment, taken on the line VIII-VIII in Fig 6 ;

Fig 9 is another horizontal section of the fourth embodiment, taken on the line IX-IX in Fig 6 ;

Fig 10 is a schematic sectional elevation of a fifth embodiment of pneumatic tool in accordance with the invention ;

Fig 11 is an incomplete sectional elevation of a sixth embodiment of pneumatic tool in accordance with the invention ; and

Fig 12 is a schematic part-sectional elevation of a seventh embodiment of pneumatic tool in accordance with the invention.

Referring first to Fig 1, this shows a sectional elevation of a known form of paving breaker tool 10, which is fully described in UK Patent Specification GB2018904 (and in its USA equivalent US4526190).

The paving breaker tool 10 essentially comprises a cylinder body 12 within which a piston 14 reciprocates in use of the tool 10. The piston 14 is driven by compressed air admitted through an air inlet 16 under the control of a manually operable throttle valve 18. An automatic change-over valve 20 admits compressed air into the cylinder body 12 alternately above the piston 14 and (through an air transfer conduit 22) to the underside of the piston 14. This alternate air admission causes the piston 14 to undergo double-acting reciprocation within the cylinder body 12, used air being exhausted in both directions of piston motion through a central piston-controlled exhaust port 24 formed in the wall of the cylinder body 12.

At the lower extremity of its movement, the piston 14 collides with a tappet 26 which transfers the kinetic energy of the piston to a tool bit 28 slidingly retained in a chuck housing 30 by a latch retainer 32.

An integral combined cylinder end closure and tool handle 34 is clamped to the upper end of the cylinder body 12 to seal off the cylinder and also act as a handle for manipulation of the tool 10. The handle 34 mounts a pivoted hand lever 36 for controlling the throttle valve 18 through a push rod 38, and incorporates an automatic oiler 40. A hollow plastics silencer casing 42 is clamped around the lower end of the cylinder body 12 so as to enclose the exhaust port 24 and thus provide a measure of noise reduction in operation of the tool 10. However, the plastics silencer casing 42 is not as robust as the remainder of the tool 10 (formed principally of thick alloy steel drop forgings), and the plastics material is also susceptible to degradation by extremes of heat and cold.

The following description details various exemplary embodiments of paving breaker providing robust but economical silencers, with the options of vibration reduction and/or substitution of custom-made forgings with plain structural hollow section and tubing. Those parts of the following embodiments which are the same as or functionally equivalent to parts of the Fig 1 paving breaker are given the same reference numerals ; accordingly for a full description of these parts, reference should be made to the above description of Fig 1, and, if necessary, reference should further be made to the previously mentioned UK

Patent Specification GB2018904 (wherein the reference numerals are not consistent with those employed in this specification).

Referring now to Figs 2 and 3, these show an air-powered paving breaker 100 constituting the first embodiment of the present invention. The breaker 100 comprises a cylinder body 12 formed as a forging or machined from heavy-wall tubing so as to have a plain bore, an integral upper external shoulder 104, an integral lower external shoulder 106, and a central exhaust port 24. A one-piece combined piston and tappet 110 reciprocates within the bore of the cylinder body 12 and the tappet portion is guided by a bush 112 retained in the bore by a circlip 114.

The upper end of the breaker 100 is closed off by the integral combined end closure and tool handle 34 which also serves as a valve housing for the automatic change-over valve 20 and is internally ported to provide requisite air passages. (The manually operable throttle valve (18) which actuates the breaker 100 is not shown in Fig 2).

Compressed air is ducted from the valve 20 to the underside of the piston/tappet 110 by a pipe 118 which is external to the cylinder body 12 (compare with Fig 1), and the air is conveyed into the lower end of the bore by a right-angle connection 120 clamped over a side port 122 in the wall of the cylinder body 102 by means of a steel band 124 tightly encircling both the connector 120 and the cylinder body 102. This is also shown in Fig 3, wherein the band 124 is depicted as endless, but in practice would probably have a joint (for example, as in a worm-drive clip). The vertical sectional plane of Fig 2 is angularly skewed (compare with Fig 3) for greater clarity of internal structural detail.

Enclosing the cylinder body 12 is a silencer casing 126 comprising a length of steel SHS (Structural Hollow Section), which has a generally square cross-section (see Fig 3). Suitable dimensions for the casing 126 are 120 millimetres by 120 millimetres with a wall thickness of 5 millimetres. The silencer casing 126 is mounted on the cylinder body 12 by means of an upper plate 128 and a lower plate 130, both plates 128 and 130 fitting within the internal section of the SHS forming the silencer casing 126.

The upper plate 128 is welded at its periphery to the inner surface of the silencer casing 126. The upper plate 128 is centrally secured to the cylinder body 12 by being clamped between the upper external shoulder 104 and the combined end closure/tool handle 34.

The lower plate 130 is a clearance fit within the silencer casing 126 and (unlike the upper plate 128) is not peripherally attached to the silencer casing 126, but instead has peripheral clearance 132 from the inner surface of the silencer casing 126. The lower plate 130 is centrally secured to the cylinder body 12 by being clamped between the lower external shoulder 106 and the chuck housing 30. An air exhaust vent 134 is cut in the lower plate 130.

Thus the upper plate 128 secures the upper end of the silencer casing 126 to the cylinder body 102, while the lower plate 130 prevents substantial movement of the lower end of the silencer casing 126 radially about the longitudinal axis of the cylinder body 102. Two bolts (not shown) extend between the handle 34 and the chuck housing 30 to hold the tool components together, and also to transmit tool-turning torque from the handle 34 to the chuck housing 30.

In use of the tool 100, used air impulsively discharged through the central exhaust port 24 has its pressure pulses damped within the internal volume of the surrounding silencer formed by the silencer casing 126 and the end plates 128, 130. The used air is then relatively smoothly discharged, with consequent lower noise levels, through the exhaust vent 134 and the clearance 132 to the ambient environment.

While the above-described silencer arrangement has the advantage of extreme simplicity, increased efficiency of air pulse damping, with consequently improved silencing, may be achieved by providing the interior of the silencer casing 126 with a permeable filling, for example mineral wool, and/or with suitable baffles which may be perforate or imperforate.

A further significant advantage is provided by the silencer arrangements of Figs 2 and 3 in which the silencer casing 126 is formed of a length of steel structural hollow section. Such material, which is a standard engineering material with consequent economy of primary cost, is inherently robust and hence resistant not only to temperature fluctuations but also to impact damage such as might be caused by the tool 100 being dropped or thrown onto rubble created by use of the tool 100. Thus the silencer casing 126 protects the internal components of the tool 100 from such damage. This protective function of the silencer casing 126 enables, for example, the air transfer conduit 118 to be designed and fabricated with a strength suited to its pressure-withstand duty without also requiring extra robustness to withstand impact damage. Thus the air transfer conduit 118 and also the cylinder body 12 can be formed of ordinary metal tubing rather than the relatively heavy and expensive drop forging of the Fig 1 prior art paving breaker. Alternatively the air transfer conduit 118 may be replaced by a length of flexible hose.

A further advantageous factor in the Fig 2 and 3 design of pneumatic tool is that any dents or distortions in the silencer casing 126, such as may be caused by impact damage, will have little or no effect on the proper functioning of the tool 100.

Referring now to Fig 4, this schematically depicts an air-powered paving breaker 200 constituting the second embodiment of the present invention. Since many of the components of the breaker 200 are conventional, these components are given the reference

numerals of the same or functionally parts of the breaker 10 of Fig 1.

The cylinder body 12 of the breaker 200 is totally enclosed by a silencer casing 202 comprising a length of steel SHS which has a generally square cross-section (but which may alternatively have a rectangular or circular cross-section). The silencer casing 202 is closed at its lower end by a welded-on plate 204 which also serves as a mounting plate by being clamped between the lower end of the cylinder body 12 and the chuck housing 30. A rubber gasket 206 is clamped between the upper end of the silencer casing 202 and the combined upper end closure/tool handle 34.

In use of the tool 200, the pulses of used air discharged from the cylinder 12 through the exhaust port 24 are damped inside the silencer formed by the casing 202, the end plate 204, and the gasket 206 backed by the closure/handle 34. The used air is then relatively smoothly and relatively quietly discharged from the silencer through vents (not shown).

The use of SHS for the silencer casing 202 provides the tool 200 with the same functional and structural advantages as previously described in relation to the tool 100 of Figs 2 and 3. These advantages include the provision of a simple and robust but economic silencer casing 202, and the ability to fabricate the cylinder body 12 and the air transfer conduit 22 of plain tubing.

Referring now to Fig 5, this depicts an air-powered paving breaker 300 constituting the third embodiment of the present invention. The tool 300 is generally similar to the tool 100 of Figs 2 and 3, and besides the basic paving breaker components previously described with reference to Fig 1, the tool 300 comprises a silencer casing 302 enclosing the cylinder body 12 and the exhaust port 24. The casing 302 comprises a length of steel SHS having a generally square cross-section.

The silencer casing 302 is closed at its lower end by a plate 304 located on the lower end of the casing 302 by pins (not shown), or by welds. The plate 304 is centrally clamped between the lower end of the cylinder body 12 and the chuck housing 30, but may alternatively be welded to the body 12.

The upper end of the silencer casing 302 is closed by an upper plate 306 located to the inside of the casing 302 by downwardly projecting pins 308. A sheet-rubber gasket 310 is sandwiched between the under-surface of the plate 306 and the upper rim of the casing 302.

The plates 304 and 306 respectively mount the lower and upper ends of the silencer casing 302 on the cylinder body 12 to form a mutually secured assembly of tool components.

In use of the tool 300, air exhausted from the cylinder 12 through the exhaust port 24 has its impulses damped within the silencer casing 302, and is ultimately exhausted to the ambient environment through one or more holes 312 formed in the lower plate 304.

Referring now to Figs 6, 7, 8 and 9, these depict a noise-reduced and vibration-reduced air-powered paving breaker 400 constituting the fourth embodiment of the present invention.

In Fig 6, the basic breaker mechanism 410 is shown in chain-dash outline and is essentially similar to a conventional paving breaker mechanism, for example as shown in Fig 1. Features of the breaker mechanism 410 which relate to the invention and/or differ from conventional features are detailed below.

The breaker cylinder body 412 is no longer closed at its upper end by a closure component which also serves as a handle, but instead is now upwardly continued by a columnar extension piece 414 having a smooth cylindrical exterior surface over the major part of its height, and a screw-threaded upper end. At about its mid-height, the exterior piece 414 has a transverse passage 416 linking its smooth exterior portion to a hollow central bore 418 leading down to the automatic change-over valve 20. The passage 416 opens into the hollow interior of a transverse handle 420 such that the arrangement functions as a short-range sliding air connection, for a purpose to be detailed below.

Above the handle 420 and around the extension piece 414 is a resilient rubber bush 422 surmounted by a lock-nut 426 screwed onto the threaded upper end of the extension piece 414. (A similar resiliently restrained sliding air connection is shown to a larger scale in Fig 11 and described below).

The breaker cylinder body 412 is further provided with a pair of laterally extending brackets 428. An upper transverse support plate 430 bears against the underside of the handle 420 and is a clearance fit around the extension piece 414.

A pair of spring assemblies 432 extend between the brackets 428 and the support plate 430. Each spring assembly 432 comprises a coiled compression spring 434 held between the plate 430 and a spring retainer cap 436 by a nut-and-bolt assembly 438.

Suitable spring rates for the springs 434 are in the range 5-30 kilogrammes per inch (1.97-11.8 kilogrammes per centimetre). The bolt of each assembly 438 is a sliding fit in the support plate 430 such that the spring assemblies 432 can contract to allow the brackets 428 and hence the cylinder body 412 to move towards the plate 430. The nut-and-bolt assemblies 438 prevents unlimited extension of each spring 434. The lock-nut 426 similarly prevents unlimited downward movement of the cylinder body 412 relative to the support plate 430. During such relative movement, the previously described sliding air connection between the handle 420 and the extension piece 414 maintains a continuous and substantially leak-free compressed air supply from the interior of the handle 420 to the valve 20.

Fig 7 shows the hollow handle 420 provided with the conventional air inlet 16, throttle valve (not visible) and its operating push-rod 38, and the throttle control lever 36, all for supplying and controlling the operating air for the tool 400.

The breaker mechanism 410 including the breaker cylinder body 412 and the upper support plate 430 is shrouded by a silencer casing 440 formed by a suitable length of square-section SHS. The casing 440 is mounted on the breaker 400 by being welded to the periphery of the support plate 430 (see Figs 6 and 8).

In order to improve the security of the mounting of the silencer casing 440 and to stabilise its alignment, the breaker 400 further includes a lower transverse support plate 442 which is rigidly clamped to the lower end of the breaker mechanism 410. The necessity of allowing the upper support plate 430 and the welded-on casing 440 to move relative to the breaker mechanism 410 for the proper operation of the resilient rubber bush 422 and the spring assemblies 432 requires that the casing 440 can move vertically past the periphery of the lower support plate 442 while being adequately supported against transverse movement and hence against excessive movement radially of the longitudinal axis of the breaker mechanism 410. At the same time, since the handle 420 is clamped to the upper support plate 430 but the handle 420 has no angular purchase on the extension piece 414, tool-turning torque applied to the handle 420 has to be transmitted from the casing 440 through the lower support plate 442 to the breaker mechanism 410.

These simultaneous requirements of the relative vertical freedom combined with lateral restraint and torque transmission are met by mounting a roller 444 in each corner of the lower support plate 442 (see Fig 9), the rollers 444 being mounted and aligned to run vertically along the inside corners of the length of square SHS forming the casing 440. (Only one such roller is depicted in Fig 6). Although not shown it is also envisaged that the rollers 444 might be substituted by a rolling ball arrangement.

A part-conical cover 446 caps the breaker 400 as an upper end closure of the casing 440 to shield the upper parts of the breaker mechanism 410.

In operation of the breaker 400, air exhausted from the cylinder body 412 enters the surrounding silencer formed by the casing 440, the upper support plate 430, and the lower support plate 442. The air pulses are damped within the silencer, and are discharged relatively smoothly and with relatively little noise (as compared to unsilenced discharge) to the ambient environment through the clearance between the periphery of the lower support plate 442 and the encompassing silencer casing 440 (see Fig 9). Additional air discharge ports (not shown) are optionally formed in the lower support plate 442 and/or in the silencer casing 440.

On the downstroke of the piston (not shown in Fig 6 but see Fig 1 for details) within the cylinder body 412, the breaker mechanism 410 jerks upwards. The brackets 428 projecting from the cylinder body 412 bear against the heads of the bolts in the nut-and-bolt assemblies 438 to lift the spring retainer caps 436 and hence the coil springs 434 against the underside of the upper support plate 430. This resilient linking of the breaker mechanism 410 to the upper support plate 430 and hence to the tool handle 420 clamped to the plate 430 damps the impulsive movements of the breaker mechanism 410 and thus reduces vibration transmitted to the handle 420. The tool operator will therefore experience less mechanical vibration as well as reduced acoustic disturbance.

The rubber bush 422 damps jarring on the rebound, for further reduction of vibration.

The previously described sliding air connection between the hollow handle 420 and the extension piece 414 allows the relative movement between the breaker mechanism 410 and the handle 420 which is necessary for vibration damping while maintaining the flow of compressed air therebetween.

The arrangement of Fig 6-9 thus provides combined noise reduction and vibration reduction in a simple, robust, and economic assembly, with inherent protection of the resilient mountings which therefore do not require to be designed or fabricated per se in an impact-resistant form.

Figs 10, 11, and 12 illustrate three further arrangements each providing noise reduction combined with vibration reduction and damage resistance. These three arrangements are each generally similar to the arrangement shown in Fig 6 and detailed above with reference to Figs 6-9. Basic similarities arise in respect of the silencer casing being a length of square (or rectangular) structural hollow section mounted on an upper support plate around which it is welded, and further supported by a lower support plate which is secured to the breaker mechanism but unsecured to the silencer casing. In each case, the tool handle is clamped to the upper side of the upper support plate. In each arrangement, the breaker mechanism has an upwardly projecting extension piece with an internal air passage slidingly linking the automatic change-over valve to the hollow centre of the tool handle to form a sliding connection for compressed air. Further, in each of the arrangements of Figs 10 and 11, the centrally mounted breaker mechanism is resiliently linked to the assembly of the handle, upper support plate, and silencer casing. The resilient link forms the vibration reduction means and comprises one or more coiled compression springs, though other forms of resilient linkage can be employed, which may for example be metallic or non-metallic. The resilient link in both arrangements further comprises an annular rubber bush through

which the upper end of the extension piece holds down the tool handle. (A somewhat different form of vibration reduction is employed in the arrangement of Fig 12, and will be described below).

In view of these similarities to the arrangement of Figs 6-9 and to avoid repetition, the following detailed description of the arrangements of Figs 10, 11, and 12 will concentrate on significant detail differences. Components and assemblies in the arrangements of Figs 10, 11 and 12 which are the same as or functionally equivalent to components and assemblies in the arrangement of Figs 6-9 will be given the same reference numerals as were used in Figs 6-9 but with the '4' replaced respectively by a '5', a '6', or a '7' ; conventional components derived from the Fig 1 arrangement have unaltered reference numerals. Accordingly, for a detailed description of any part of the arrangements of Figs 10, 11, or 12 not given below, reference should be made to the relevant part of the description of Figs 6-9.

Specifically referring now to Fig 10, this schematically illustrates a paving breaker 500 forming the fifth embodiment of the present invention. In place of the brackets 428 in the Fig 6 breaker 400, the extension piece 514 is formed with a shoulder near its lower end to bear against the lower end of the coiled compression spring 534. The lower support plate 542 is roller-free and a sliding fit within the silencer casing 540 for lateral restraint and torsional linking of the casing 540 to the breaker mechanism 510.

The paving breaker 500 functions to provide noise reduction and vibration reduction in the same manner as the breaker 400 of Figs 6-9.

Turning now to Fig 11, this shows part of a paving breaker 600 constituting the sixth embodiment of the present invention. The breaker 600 is largely identical to the breaker 400 (compare Fig 11 with Fig 4), substantive detail differences lying mainly in an asymmetrical arrangement within the breaker 600, and in the provision of tiebolts 650 (only one being visible in Fig 11) anchoring the extension piece 614 to the chuck holder 30.

Turning finally to Fig 12, this shows a paving breaker 700 constituting a seventh embodiment of the present invention. The breaker 700 is generally similar to the breaker 500 shown in Fig 10, but differs significantly in respect of the means provided for reducing vibration.

In comparison to the Fig 10 arrangement, in the breaker 700 the combined upper-end cylinder closure and automatic change-over valve housing (715 in Fig 12) is a component which is now distinct from and relatively movable with respect to the extension piece 714. The cylinder closure/valve housing 715 is slidingly sealed around the lower end of the extension piece 714. The closure/housing 715 is prevented from being pulled or pushed off the lower end of the extension piece 714 by an integral shoulder or flange 760 provided thereon.

The extension piece 714 itself is also in two parts, a lower tubular component 762 providing the air passages 716 and 718, and an upper, screw-threaded stud 764 which has its lower end screwed into the upper end of the tubular component 762. The nut 726 acts through the washer 724 and the resilient rubber bush 722 to resiliently restrain the extension piece 714 against all except a limited downward movement relative to the handle 720. Upward movement of the extension piece 714 relative to the handle 720 is entirely prevented by abutment of the upper end of the tubular component 762 with the portion of the handle 720 surrounding the bore for the stud 764.

In considering vibration damping in the breaker 700, it is important to note that the closure/housing 715 slides on the relatively immobile tubular component 762 of the extension piece 714 in the manner of an inverted piston/cylinder arrangement, with the closure/housing 715 playing the part of the piston. The cross-sectional area of the tubular component 762 subtracts from the up-facing area of the "piston" 715.

Thus in operation of the breaker 700 with the internal air passages between the throttle valve 18 and the change-over valve 20 filled with compressed air, this internal pneumatic pressurisation of the closure/housing 715 acts on the differential "piston" areas theron to provide a net downward bias on the closure/housing 715 and the remainder of the breaker mechanism 710 attached thereto. Therefore upwardly impulsive movement of the breaker mechanism 710 is resiliently counteracted by the pneumatically -induced downward bias to produce the pneumatic equivalent of the mechanical spring 534 present in the breaker 500 of Fig 10, to provide vibration reduction. Downward rebound of the breaker mechanism 710 is resiliently limited and damped by the rubber bush 722 acting through the extension piece 716 and the shoulder 760 when the closure/housing 715 slides down the tubular component 762 into contact with the shoulder 760.

The silencer casing 740 is formed of a length of structural hollow section as in previously described embodiments, and provides noise reduction in the same manner.

Thus seven exemplary embodiments of the invention have been described, all providing noise reduction and/or vibration reduction by means which are simple, robust, and economic per se, and which furthermore facilitate the optional construction of the air tool as a whole from relatively low cost materials without compromising essential robustness and damage resistance.

While certain modifications and variations of the invention have been described above, the invention is not restricted thereto, and other modifications and vibrations can be adopted without departing from the

scope of the invention.

Claims

1. A pneumatic reciprocating tool comprising a cylinder body and an air-operated piston which reciprocates within said cylinder body during sustained use of said tool, air being exhausted from an exhaust port in said cylinder body during such use, said pneumatic tool further comprising a silencer arrangement substantially totally surrounding said cylinder body, including said exhaust port therein, characterised in that said silencer arrangement comprises a length of metallic structural hollow section whose longitudinal axis is generally parallel to the longitudinal axis of said cylinder body, and mounting means for mounting said silencer arrangement on said pneumatic tool.

2. A pneumatic reciprocating tool as claimed in Claim 1, wherein said silencer arrangement in the form of a metallic structural hollow section provides a protective casing for an optional vibration reducing arrangement linking the cylinder body to the remainder of the tool.

3. A pneumatic reciprocating tool as claimed in Claim 1 or 2, wherein said silencer arrangement in the form of a metallic structural hollow section provides a protective casing for the cylinder body itself and for any associated pneumatic conduit system.

4. A pneumatic reciprocating tool as claimed in Claim 1, wherein said mounting means for mounting said silencer arrangement on said pneumatic tool comprises a pair of plates mutually spaced apart along the longitudinal axis of said length of structural hollow section, one of said plates being secured to said length of structural hollow section and the other of said plates being unsecured to said length of structural hollow section and loosely fitting therein while being substantially rigidly secured to said cylinder body, the one of said plates which is secured to said length of structural hollow section being rigidly secured to said cylinder body.

5. A pneumatic reciprocating tool as claimed in Claim 2, wherein said mounting means for mounting said silencer arrangement on said pneumatic tool comprises a pair of plates mutually spaced apart along the longitudinal axis of said length of structural hollow section, one of said plates being secured to said length of structural hollow section and the other of said plates being unsecured to said length of structural hollow section and loosely fitting therein while being substantially rigidly secured to said cylinder body, the one of said plates which is secured to said length of structural hollow section being resiliently linked through a resilient vibration reducing means to said cylinder body.

6. A pneumatic reciprocating tool as claimed in Claim 5, having one of said plates resiliently linked to said cylinder body wherein the other said plate is rollingly coupled by a ball or roller system thereon to the inner surface of the said length of structural hollow section such as to permit movement of the other said plate and of the cylinder body along the longitudinal axis of said length of structural hollow section while substantially preventing rotation of said other plate and of the cylinder body about the longitudinal axis of said length of structural hollow section such that tool-turning forces applied by a tool operator to a tool handle secured to said length of structural hollow section are transmitted to said cylinder body and to a tool bit rotationally secured thereto despite the resilient linking of the one said plate and of the length of structural hollow section secured thereto with the cylinder body through said resilient vibration reducing means.

7. A pneumatic reciprocating tool as claimed in Claim 3, wherein the cylinder body is fabricated of plain metal tubing.

8. A pneumatic reciprocating tool substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

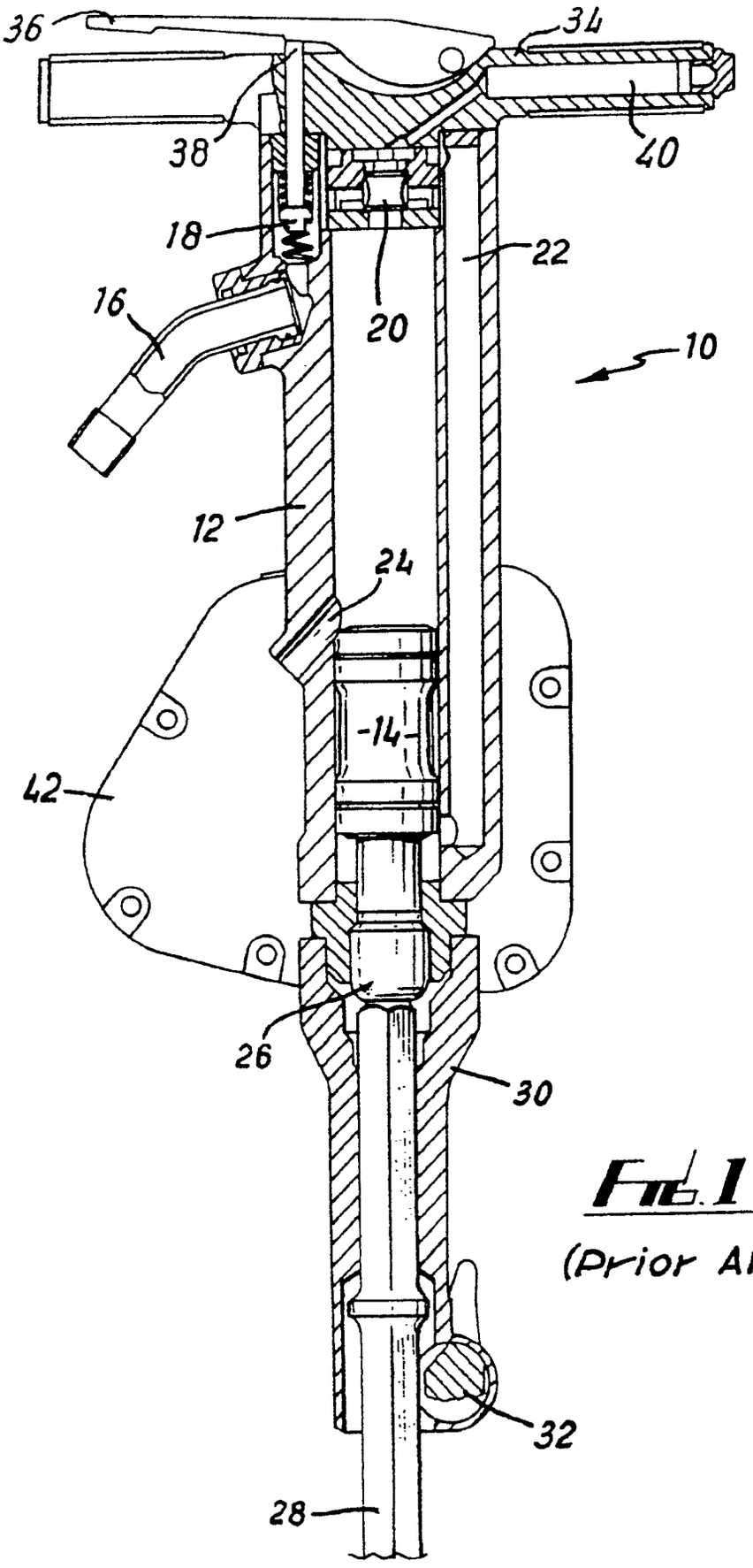

FIG. 1
(Prior Art)

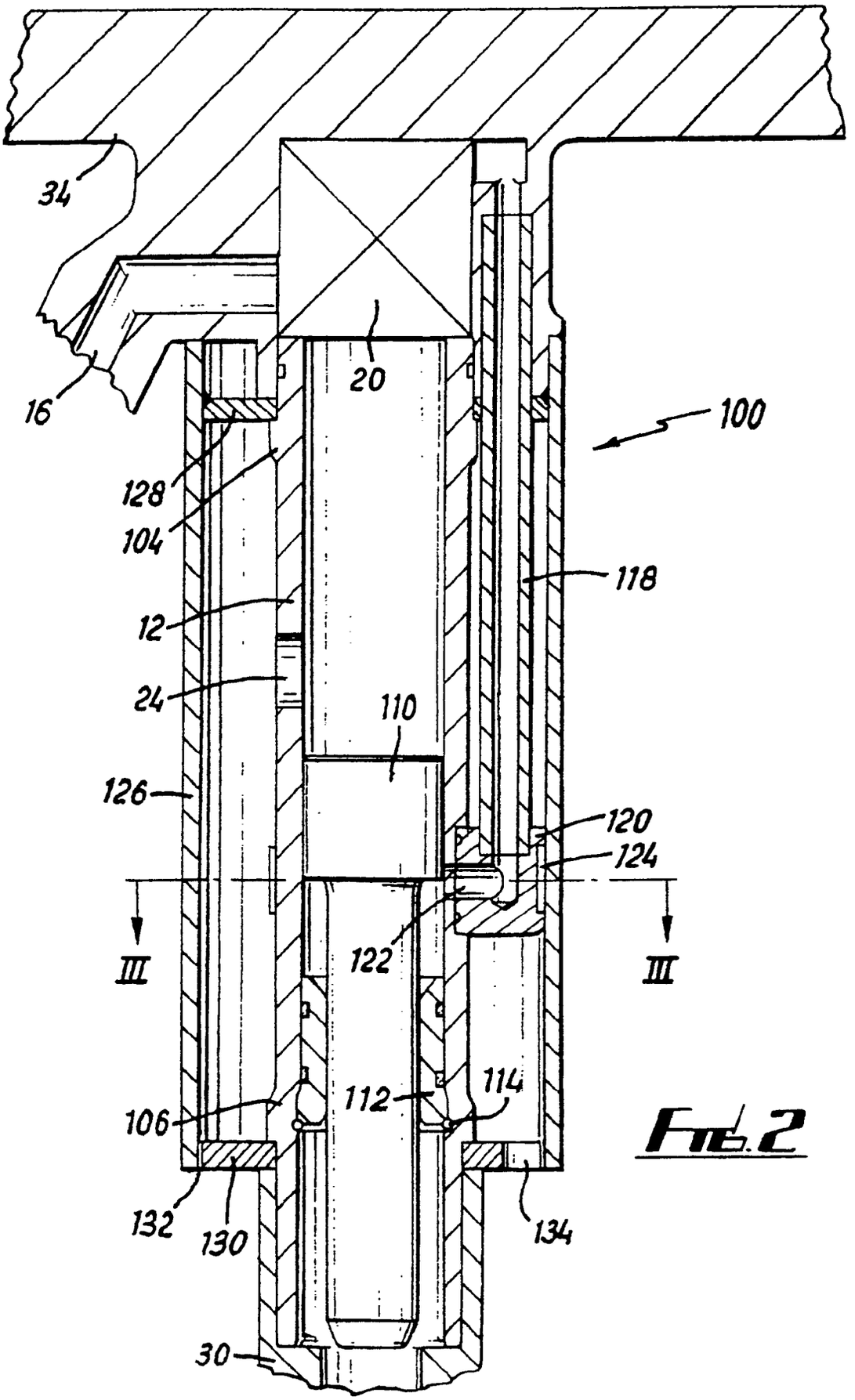
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FIG. 2

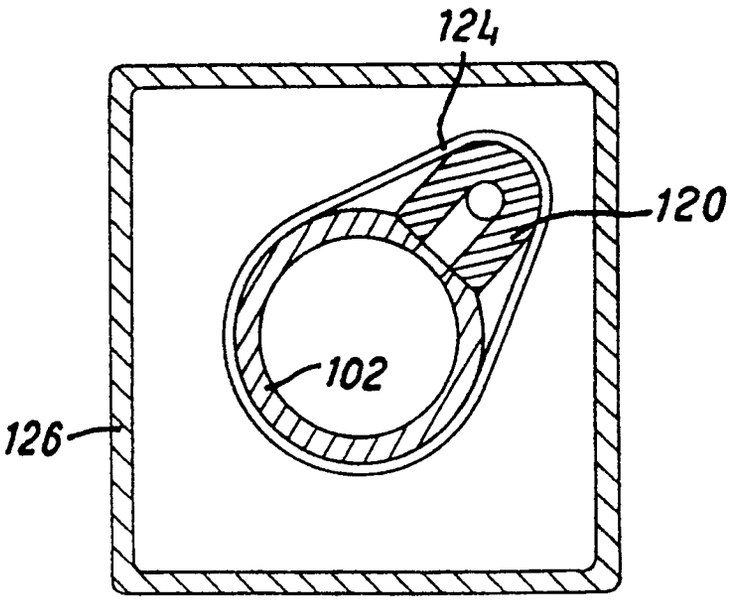

FIG. 3

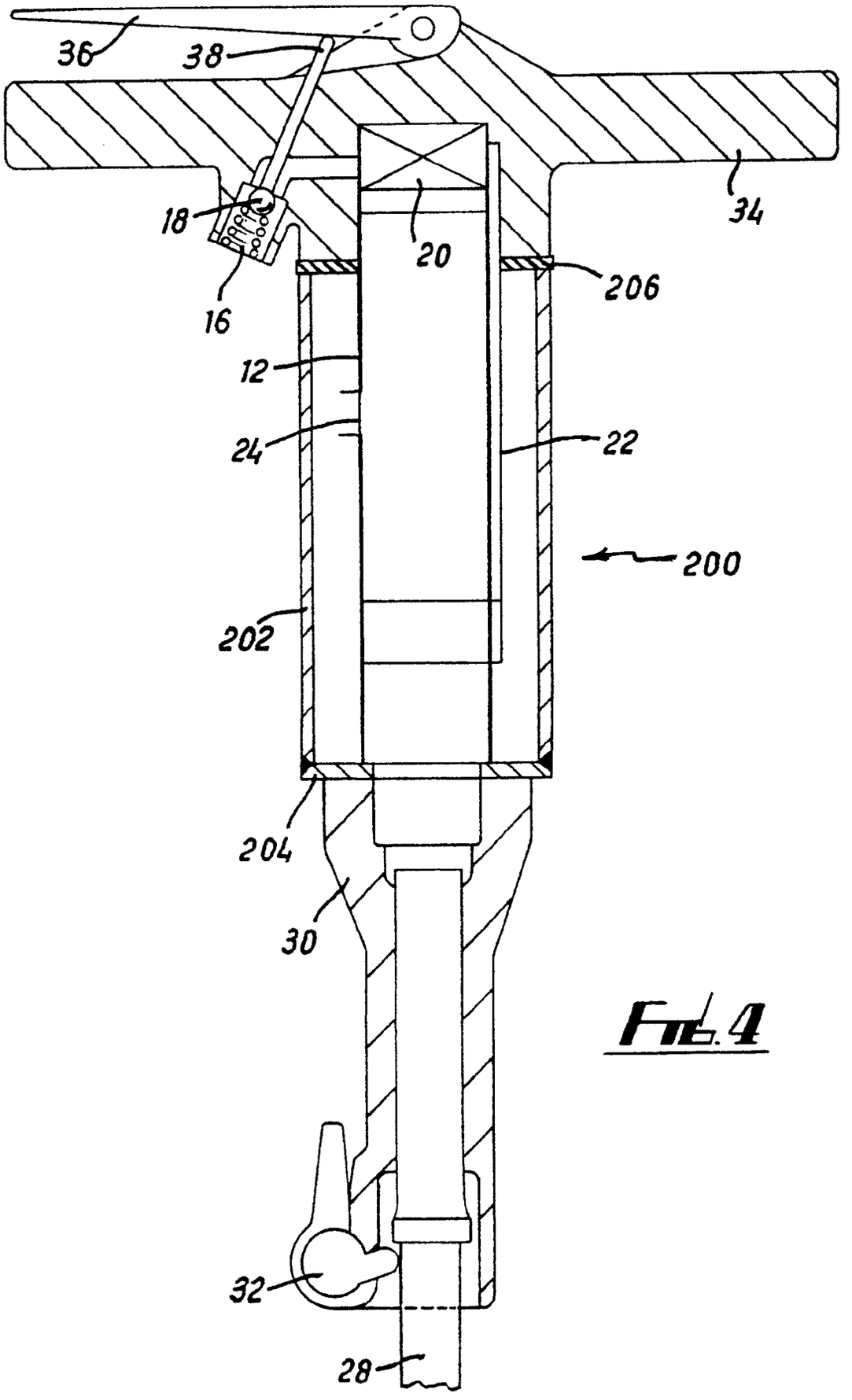

FIG. 4

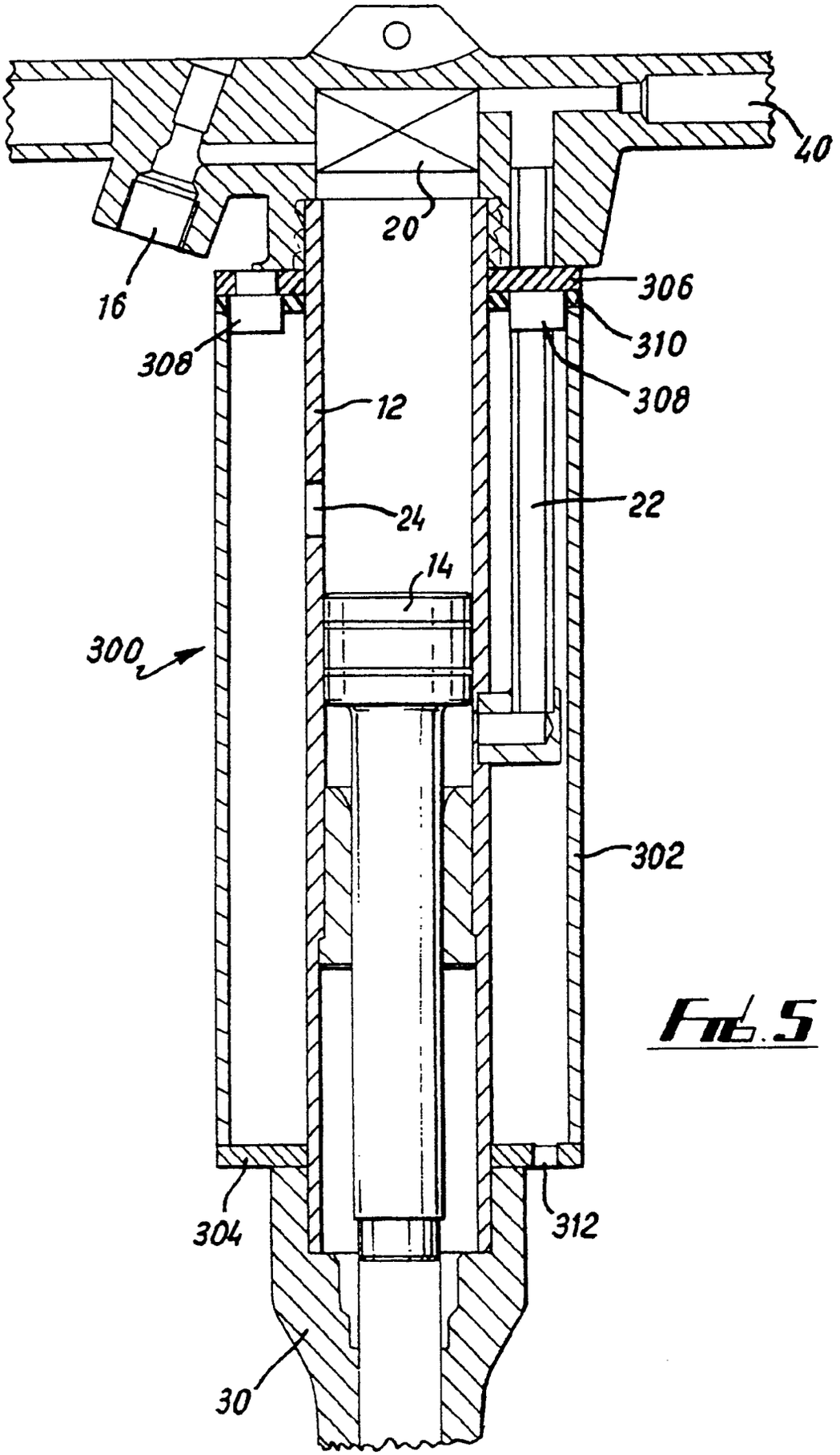

FIG. 5

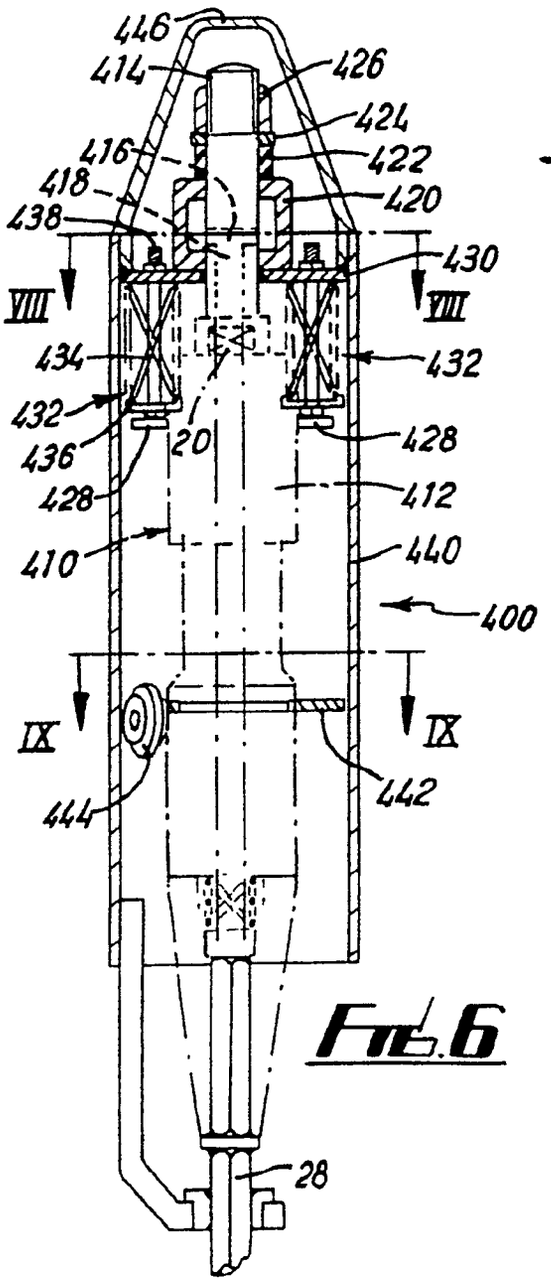

FIG.6

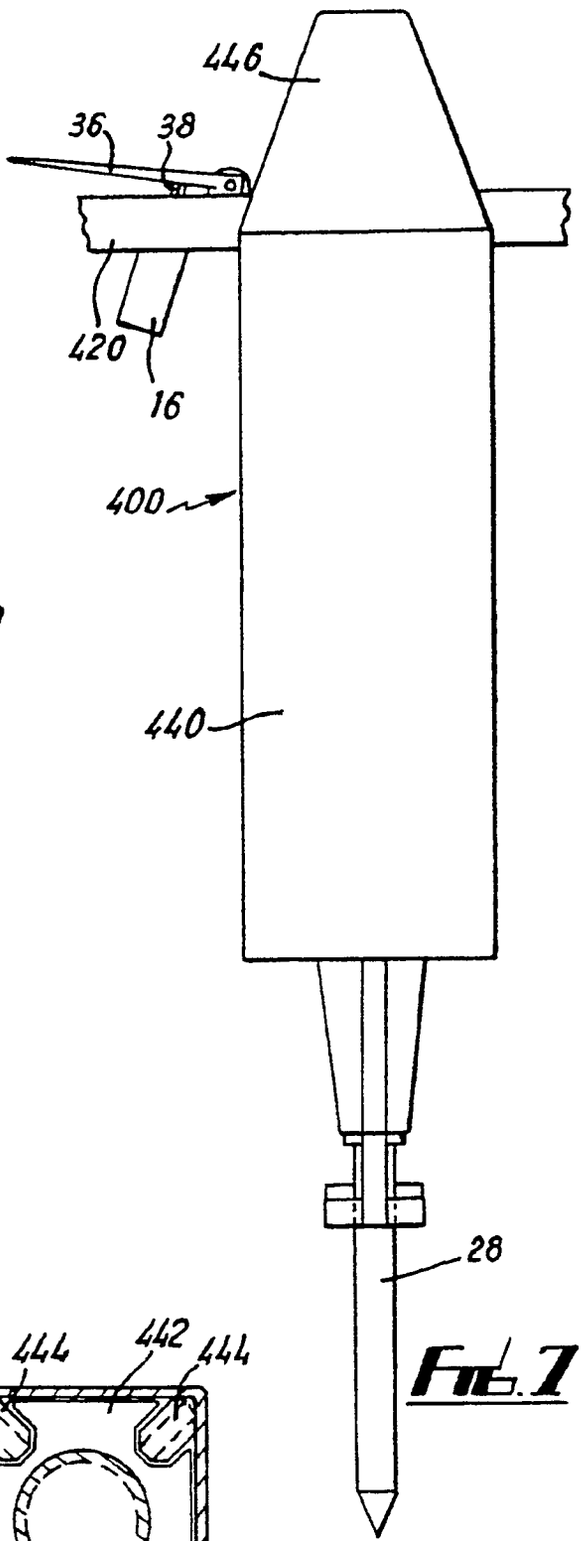

FIG.7

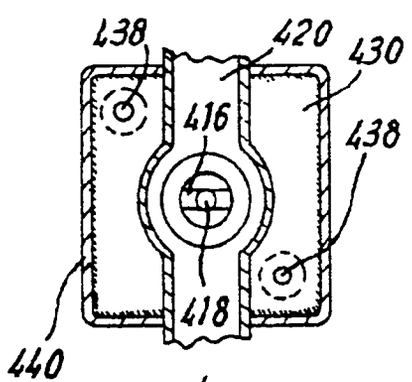

FIG.8

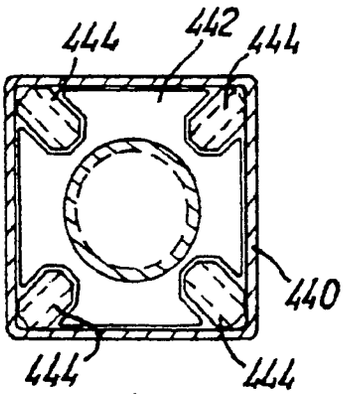

FIG.9

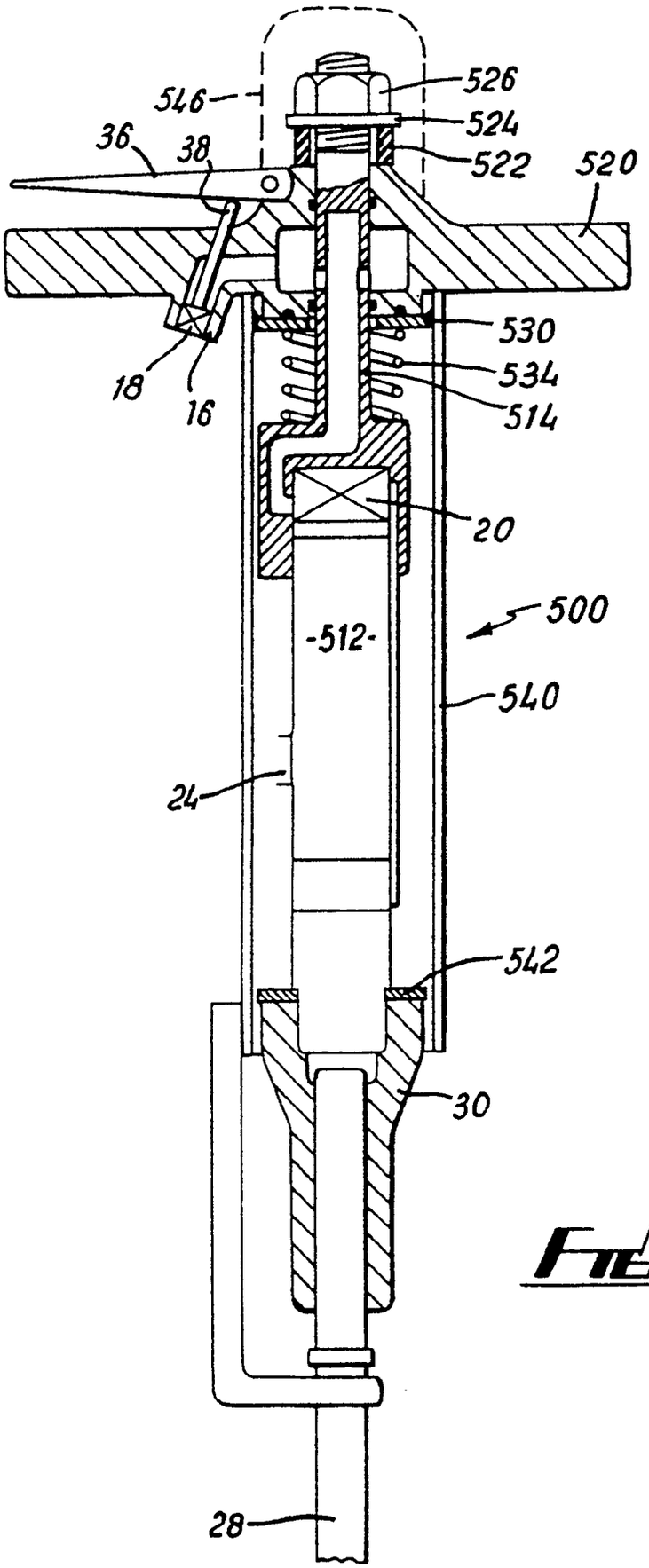
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FIG. 10

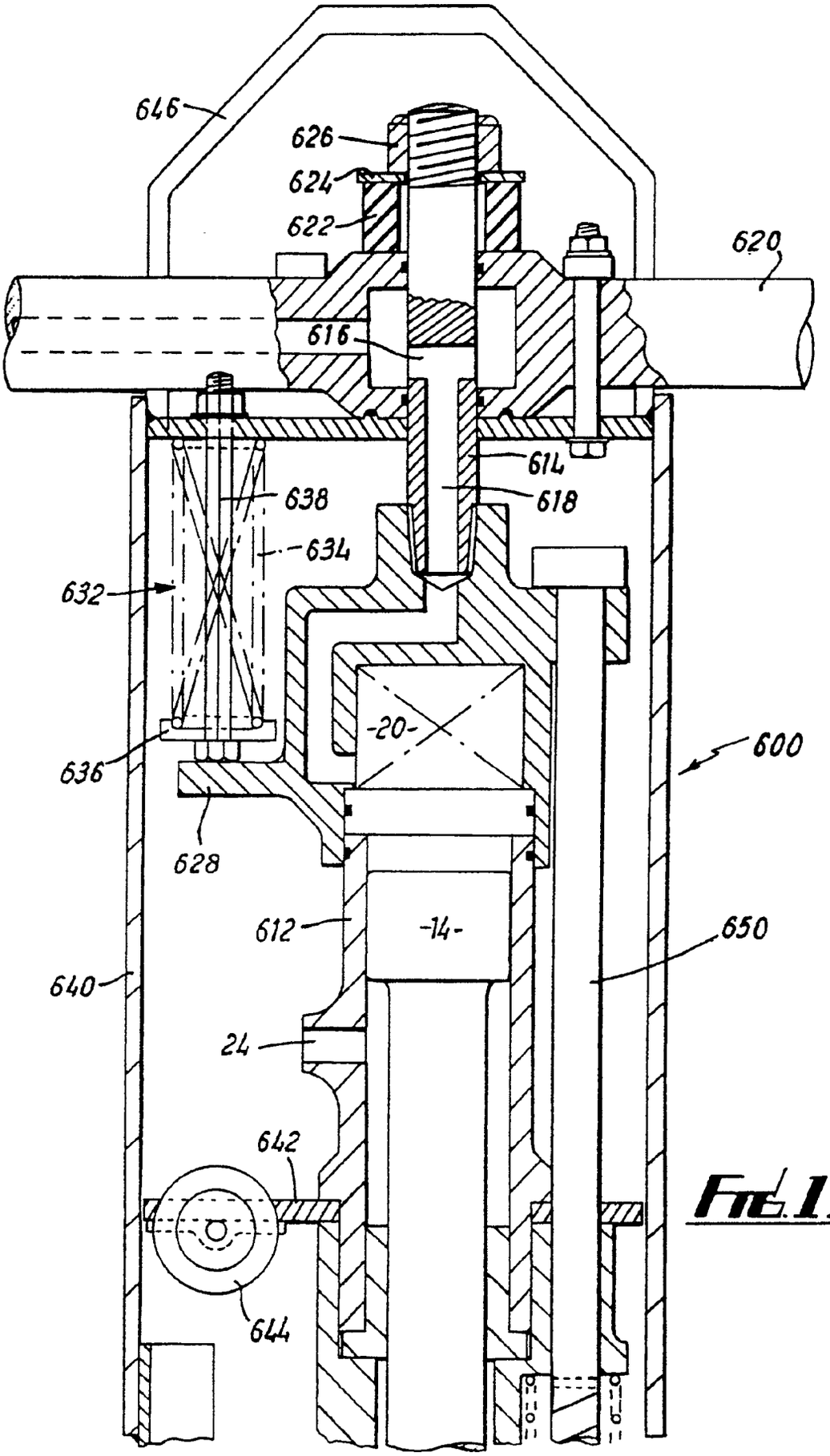
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FIG. 11

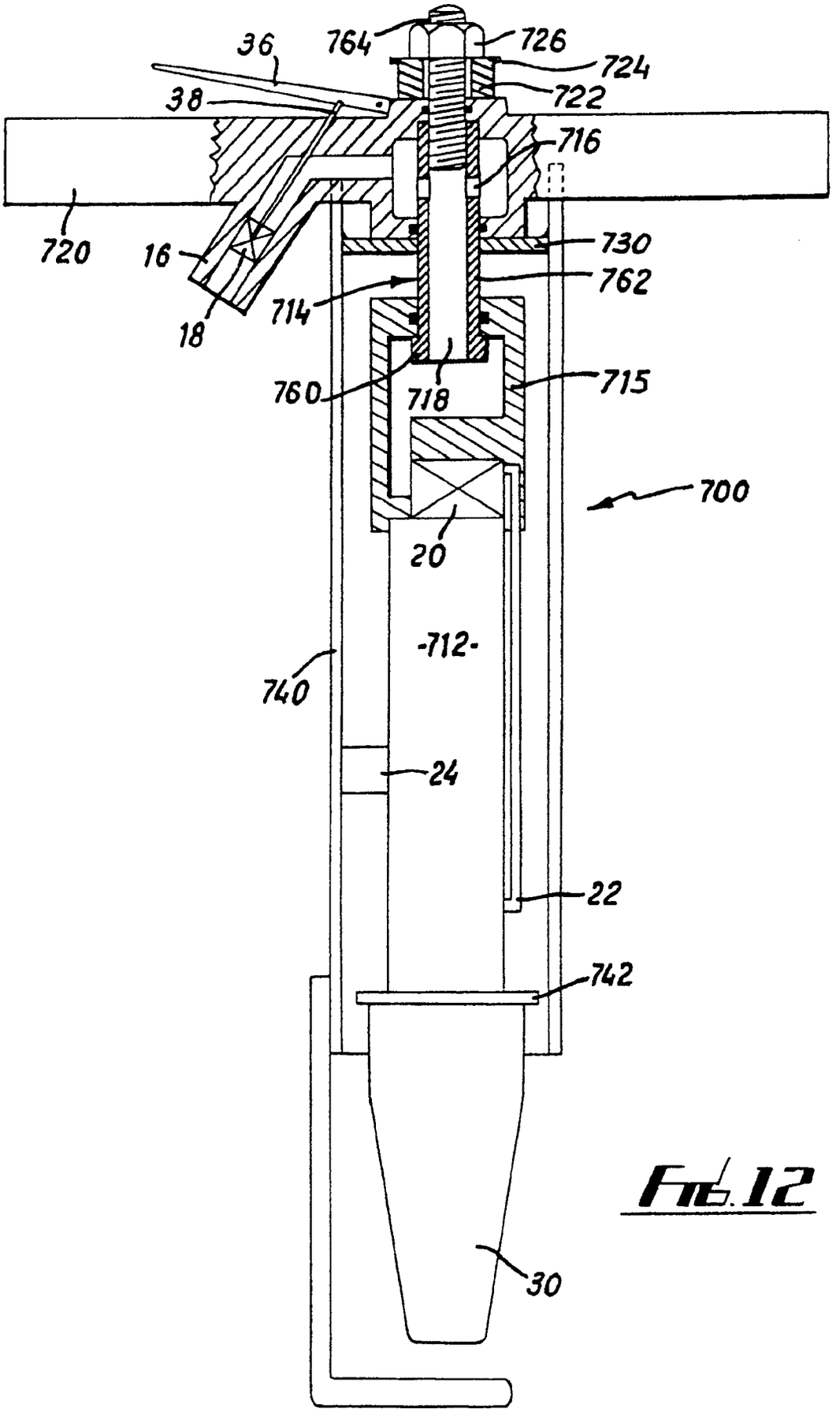
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FIG. 12

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 91 30 0632

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	FR-A-2388646 (MACO-MEUDON) * page 3, lines 3 - 17; figures *	1, 3, 7	B25D17/11 B25D17/24
X	CH-A-413756 (CLARKE) * page 2, left-hand column, lines 22 - 31; figures *	1, 3, 7	
X	FR-A-2209311 (MACO MEUDON) * the whole document *	1-3	
X	EP-A-194347 (WACKER-WERKE) * abstract; figures *	1-3	
A	FR-A-1353634 (MEUDON) * page 1, right-hand column, lines 11 - 28; figures *	1, 3	TECHNICAL FIELDS SEARCHED (Int. Cl.5) B25D
A	DE-A-3440530 (HENZE) * abstract; figures *	1	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	12 APRIL 1991	WEIAND T.

CATEGORY OF CITED DOCUMENTS

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