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(54) AIR COMPRESSOR APPARATUS

(57) An air compressor is disclosed, which can keep the pressure of air supply less than a safety pressure without using a safety valve, so that a tire can be inflated without exceeding a safety pressure thereof. One feature of the air compressor is that: when the piston body, which conducts reciprocating motion in the cylinder, reaches top dead center, a space is existed between the head of the piston body and the top wall of the cylinder. Another feature of the air compressor is that: an adjusting bolt is used to adjust the volume of the auxiliary air chamber to change the maximum permissible output pressure of the air compressor to suit an object. As such, the air compressor does not require a mechanical safety valve to release air for limiting the pressure of air supply. The air compressor can protect a tire from over-inflation and save the manufacturing cost.

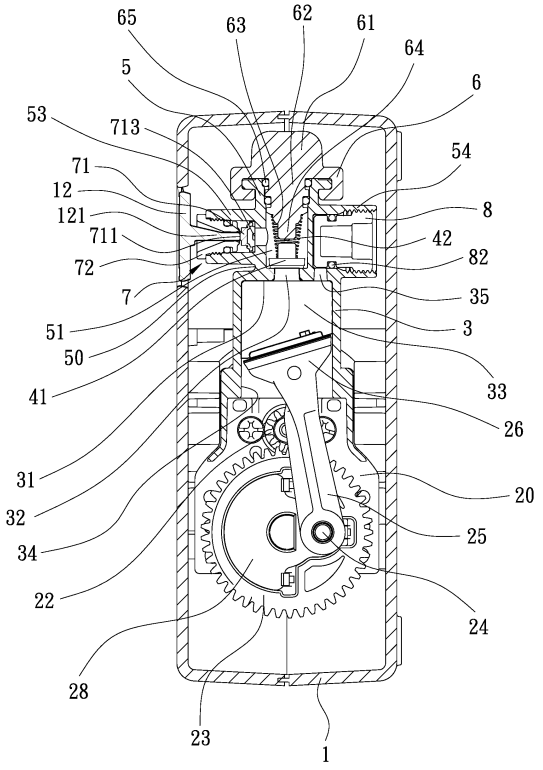

FIG. 4

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Description

(a) Technical Field of the Invention

[0001] The present invention relates to an air compressor, which can prevent a tire from over-inflation without using a mechanical safety valve.

(b) Description of the Prior Art

[0002] The applicant has been dedicated to developing air compressors for a long time. At the early days, the applicant successfully converted a labor-intensive and complicated air compressor into an air compressor that is simple in structure and can be quickly assembled. In US Pat. No. 7,462,018, an outlet header is provided with a plurality of ducts or outlets, one of which can be connected with a safety valve. When a piston body, which conducts reciprocating motion in a cylinder, reaches top dead center, the head of the piston body almost contacts the top wall of the cylinder; there is no space between the head of the piston body and the top wall of the cylinder. The air compressor is installed with a safety valve. When the air compressor is used to inflate a tire, if the pressure of the air supply is greater than a safety pressure set for the tire, the safety valve can act automatically to release air into the environment. However, after the safety valve has served for a long time, the valve may be stuck, so that it cannot work properly upon a high pressure of the compressed air produced in the air compressor. Thus, a tire may be excessively inflated, thereby causing a blowout.

SUMMARY OF THE INVENTION

[0003] One object of the present invention is to provide an air compressor, which allows air supply to keep less than a safety pressure without using a mechanical safety valve, so that a tire can be inflated without exceeding a safety pressure thereof.

[0004] To achieve the above object, the present invention offers a solution as follows:

The air compressor includes a box and an electrically operated compressor unit installed in the box, wherein a motor drives a piston body to conduct reciprocating motion in a cylinder to produce compressed air, which can be transferred into an air storage container provided with a plurality of outlets; when the piston body reaches top dead center, a space is existed between a head of the piston body and a top wall of the cylinder; a tube is formed integrally with the air storage container and on the cylinder, wherein the tube does not communicate with the air storage container, an adjusting bolt being threadedly fitted into the tube to define an auxiliary air chamber communicating with an inner space of the cylinder via an auxiliary exit hole.

[0005] As described above, one feature of the present invention is that: when the piston body reaches top dead center, a space is existed between the head of the piston body and the top wall of the cylinder. Another feature of the present invention is that: the auxiliary air chamber cooperates with the inner space of the cylinder to increase the operational security. As compared to the conventional technology, the air compressor of the present invention can keep the pressure of air supply less than a safety pressure without using a mechanical safety valve, so that a tire can be inflated without exceeding a safety pressure thereof, and at the same time, the manufacturing cost of the air compressor can be reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006]

FIG 1 shows a 3-dimensional view of an air compressor, including a box and a compressor unit, according to one embodiment of the present invention.
FIG 2 shows an exploded view of the compressor unit.
FIG 3 shows a 3-dimensional view of the compressor unit.
FIG 4 shows a schematically sectional view of the air compressor.
FIG 5 shows an enlarged, partial view of the air compressor shown in FIG 4.
FIG 6 shows a schematically sectional view of the air compressor, wherein a relief valve is depressed for releasing air into the environment.
FIG 7 shows a schematically sectional view of the air compressor, wherein an adjusting bolt is turned for adjusting the volume of an auxiliary air chamber.
FIG 8 shows a schematically sectional view of the air compressor, wherein the piston body has conducted an upward stroke to reach top dead center, and a space is existed between the head of the piston body and the top wall of the cylinder.
FIG 9 shows another schematically sectional view of the air compressor.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0007] For further illustrating the technical contents of the present invention, one embodiment is provided in the following paragraphs.

[0008] Referring first to FIGS. 1 through 4, an air compressor according to one embodiment of the present invention is shown, which generally includes a box 1 and a compressor unit installed in the box 1, wherein the box 1 is provided with a switch 11, a button 12, and a transparent window 13. The compressor unit includes a cylinder 3, which allows a piston body 25 to operate therein, and a main frame 20, which is formed integrally with the cylinder 3 and used to mount a motor 21.

[0009] The main frame 20 also mounts a transmission mechanism, which includes a pinion 22 and a gear 23 provided with a counterweight 28 and a crankpin 24. The motor 21 is fitted with a cooling fan 27. The motor 21 can derive the transmission mechanism to have the piston body 25 conduct reciprocating motion along an inner surface 34 of the cylinder 3 to produce compressed air, which can overcome a compression spring 42 and thus push a plug 41 up, so that the compressed air can be transferred into an air storage container 5 via an exit hole 32.

[0010] The air storage container 5 is provided with a plurality of outlets 52, 53, 55 (see also FIG 9), wherein the outlet 52 is connected with a hose 91; the outlet 53 is connected with a relief valve 7; the outlet 55 is connected with a pressure gauge 9.

[0011] One primary feature of the present invention is that: when the piston body 25 has conducted an upward stroke to reach top dead center, a space 33 is existed between the top wall 31 of the cylinder 3 and the head 26 of the piston body 25, as shown in FIG 7. Therefore, the pressure of the compressed air does not exceed a predetermined pressure set for a tire to be inflated, without requiring the compressor unit to install a mechanical safety valve, so that a user can inflate a tire more conveniently, and the tire can be protected from over-inflation. Another feature of the present invention is that a tube 54 is formed integrally with the air storage container 5 and on the cylinder 3, wherein the tube 54 does not communicate with the inner space 51 of the air storage container 5. The tube 54 defines therein an auxiliary chamber 541 communicating with the inner space 33 of the cylinder 3. An adjusting bolt 8 is threadedly fitted into the tube 54 for adjusting the volume of the auxiliary chamber 541.

[0012] Referring now to FIGS. 4 through 8, the bottom 50 of the air storage container 5 is joined to the top wall 31 of the cylinder 3. The top wall 31 defines the exit hole 32 and an auxiliary exit hole 35. The exit hole 32 allows the inner space 33 of the cylinder 3 to communicate with the inner space 51 of the air storage container 5. The auxiliary exit hole 35 allows the inner space 33 of the cylinder 3 to communicate with the auxiliary chamber 541 of the tube 54. The plug 41 is placed on the exit hole 32 defined on the top wall 31. A rectangular top cover 6 has a rotating handle 61 at its outer surface and a central column 62 extending from its inner surface (see FIG 5). The central column 62 has a base portion and a reduced portion 64 extending from the base portion, wherein a step 63 is formed between the base portion and the reduced portion 64. The base portion of the central column 62 is provided with a plurality of annular protrusions 621 and defines a plurality of annular grooves 622 at its outer surface. A plurality of seal rings 65 are fitted into the annular grooves 622 of the central column 62.

[0013] As shown in FIG 3, the top cover 6 can be coupled to the air storage container 6 by turning the rotating handle 61. One end of the compression spring 42 is engaged with the plug 41, while an opposite end of the compression spring 42 is engaged with a lowest one of the annular protrusions 621.

[0014] Referring to FIGS. 2 and 5, the relief valve 7 includes a hollow soft cap 71 having a tip 711 and an annular portion provided with a plurality of spaced protrusions 712 at its outer surface. Between two adjacent protrusions 712 defines a gap 713. Amounting bolt 72 defines a central through hole 722 extending from an opening 721 at one end of the mounting bolt 72, wherein the central through hole 722 of the mounting bolt 72 has a diameter smaller than the opening 721 of the mounting bolt 72. The soft cap 71 is fitted in the outlet 53. The mounting bolt 72 is fitted into the outlet 53 to have an opposite end of the mounting bolt 72 located near the soft cap 71. The annular portion of the soft cap 71 is engaged with an inner surface of the outlet 53. The tip 711 of soft cap 71 is located near the opposite end of the mounting bolt 72. A push bar 121 of the button 12 is inserted through the through hole 722 of the mounting bolt 72 to touch the tip 711 of the soft cap 71. The button 12 may be depressed to allow its push bar 121 to compress the soft cap 71 and thus deform the soft cap 71, so that excessive air in an object to be inflated can be released into the environment via the outlet 53 which connects the relief valve 7, as shown in FIG 6. The adjusting bolt 8, which is threadedly fitted into the tube 54, defines at its outer surface an annular groove 81 to be fitted with a seal ring 82. Turning the adjusting bolt 8 can adjust the volume of the auxiliary chamber 541, which in turn affect the inner space 33 of the cylinder 3, as shown in FIGS. 5 and 7.

[0015] When the piston body 25 has conducted an upward stroke to reach top dead center, as shown in FIG 7, the space 33 is existed between the head 26 of the piston body 25 and the top wall 31 of the cylinder 3; namely, the head 26 of the piston body 25 is not located near the top wall 31 of the cylinder 3. As shown, the space 33 has a depth indicated by the symbol (X) between the top surface of the head 26 of the piston body 25 and the top wall 31 of the cylinder 3. Furthermore, when the piston body 25 conducts an upward stroke, the compressed air contained in the inner space 33 of the cylinder 3 can overcome the compression spring 42 to push the plug 41 up and thus flow into the inner space 51 of the air storage container 5 via the exit hole 32 defined on the top wall 31 of the cylinder 3, and then can flow into an object via one of the outlets 52, 53, 55. Furthermore, the upward movement of the plug 41 can be limited by the reduced portion 64 of the central column 62 of the top cover 6, as shown in FIGS. 7 and 9.

[0016] Referring to FIGS. 6 and 7, a user may turn the adjusting bolt 8 fitted at the tube 54 to adjust the volume of the auxiliary air chamber 541 that communicates with the inner space 33 of the cylinder 3, so that the pressure of the compressed air produced in the cylinder 3 will be less than a safety pressure for an object to be inflated.

[0017] The distance (X) between the head 26 of the

piston body 25 and the top wall 31 of the cylinder 3 can be obtained from the formula: X = S / (P'-1), where S is the piston stoke; P' is the ratio between the maximum permissible output pressure and the atmospheric pressure.

[0018] For example: if the atmospheric pressure is about 101.325 KPa, the piston stroke S is 16, and the maximum permissible output pressure is 350 KPa, then P' equals to 350 KPa / 101.325KPa = 3.45, and thus the distance X equals to 16 / (3.45-1) = 6.53. To change the maximum permissible output pressure of the compressor unit, a user may turn the adjusting bolt 8 fitted at the tube 54 to change the volume of the auxiliary chamber 541 which communicates with the inner space 33 of the cylinder 3. As such, the compressor unit does not require a mechanical safety valve to limit the pressure of the compressed air produced in the cylinder, so that a user can inflate a tire more conveniently, and the manufacturing cost of the compressor unit can be reduced.

[0019] In light of the foregoing, one feature of the present invention is that when the piston body 25, which conducts reciprocating motion in the cylinder 3, reaches top dead center, a space is existed between the head 26 of the piston body 25 and the top wall 31 of the cylinder 3, so that the pressure of the compressed air produced in the cylinder 3 will not exceed a safety pressure for a tire to be inflated. Another feature of the present invention is that the adjusting bolt 8 can adjust the volume of the auxiliary air chamber 541 of the tube 54 to adjust the maximum permissible output pressure of the compressor unit. These features render the present invention useful.

[0020] The above embodiment and drawings are not for limiting the shape and style of the present invention. Persons with ordinary skills in the art can make variations or modifications to the embodiment without deporting from the scope of the present invention.

Claims

1. An air compressor including a box (1) and an electrically operated compressor unit installed in the box (1), wherein a motor (21) drives a piston body (25) to conduct reciprocating motion in a cylinder (3) to produce compressed air, which is transferred into an air storage container (5) provided with a plurality of outlets (52, 53, 55);
   the air compressor **characterized in that**: when the piston body (25) reaches top dead center, a space is existed between a head (26) of the piston body (25) and a top wall (31) of the cylinder (3); a tube (54) is formed integrally with the air storage container (5) and on the cylinder (3), wherein the tube (54) does not communicate with an inner space (51) of the air storage container (5), an adjusting bolt (8) being threadedly fitted into the tube (54) to define an auxiliary air chamber (541) communicating with an inner space (33) of the cylinder (3) via an auxiliary exit hole (35).

2. The air compressor of claim 1, further **characterized in that**: the box (1) is provided with a button (12); one of the outlets (52, 53, 55) is connected with a relief valve (7), which includes a hollow soft cap (71) having a tip (711) and an annular portion provided with multiple spaced protrusions (712) at its outer surface, between two adjacent protrusions (712) defining a gap (713); a mounting bolt (72) defining a central through hole (722) extending from an opening (721) at one end of the mounting bolt (72), the central through hole (722) of the mounting bolt (72) having a diameter smaller than the opening (721) of the mounting bolt (72), wherein the soft cap (71) is fitted in the outlet that connects the relief valve (7), the mounting bolt (72) is fitted into the outlet that connects the relief valve (7) to have an opposite end of the mounting bolt (72) located near the soft cap (71), the annular portion of the soft cap (71) is engaged with an inner surface of the outlet that connects the relief valve (7), the tip (711) of soft cap (71) is located near the opposite end of the mounting bolt (72), and a push bar (121) of the button (12) is inserted through the through hole (722) of the mounting bolt (72) to touch the tip (711) of the soft cap (71); whereby the button (12) may be depressed to allow its push bar (121) to compress the soft cap (71) and thus deform the soft cap (71), so that excessive air in an object to be inflated may flow through the gaps (713) of the soft cap (71) and the through hole (722) of the mounting bolt (72) to be released into the environment.

3. The air compressor of claim 1, further **characterized in that**: the adjusting bolt (8) defines at its outer surface an annular groove (81) to be fitted with a seal ring (82), the volume of the auxiliary chamber (541) being adjusted by turning the adjusting bolt (8).

4. The air compressor of claim 1, further **characterized in that**: a bottom (50) of the air storage container (5) is joined to the top wall (31) of the cylinder (3), the top wall (31) defining an exit hole (32) which allows the inner space (33) of the cylinder (3) to communicate with the inner space (51) of the air storage container (5); a plug (41) is placed on the exit hole (32) of the top wall (31); a rectangular top cover (6) has a rotating handle (61) at its outer surface and a central column (62) extending from its inner surface, the central column (62) having a base portion and a reduced portion (64) extending from the base portion, wherein a step (63) is formed between the base portion and the reduced portion (64), the base portion of the central column (62) being provided with a plurality of annular protrusions (621) and defines a plurality of annular grooves (622) at its outer surface; a plurality of seal rings (65) are fitted into the annular

grooves (622) of the central column (62); the top cover (6) is coupled to the air storage container (6) by turning the rotating handle (61); one end of a compression spring (42) is engaged with the plug (41), and an opposite end of the compression spring (42) is engaged with a lowest one of the annular protrusions (621).

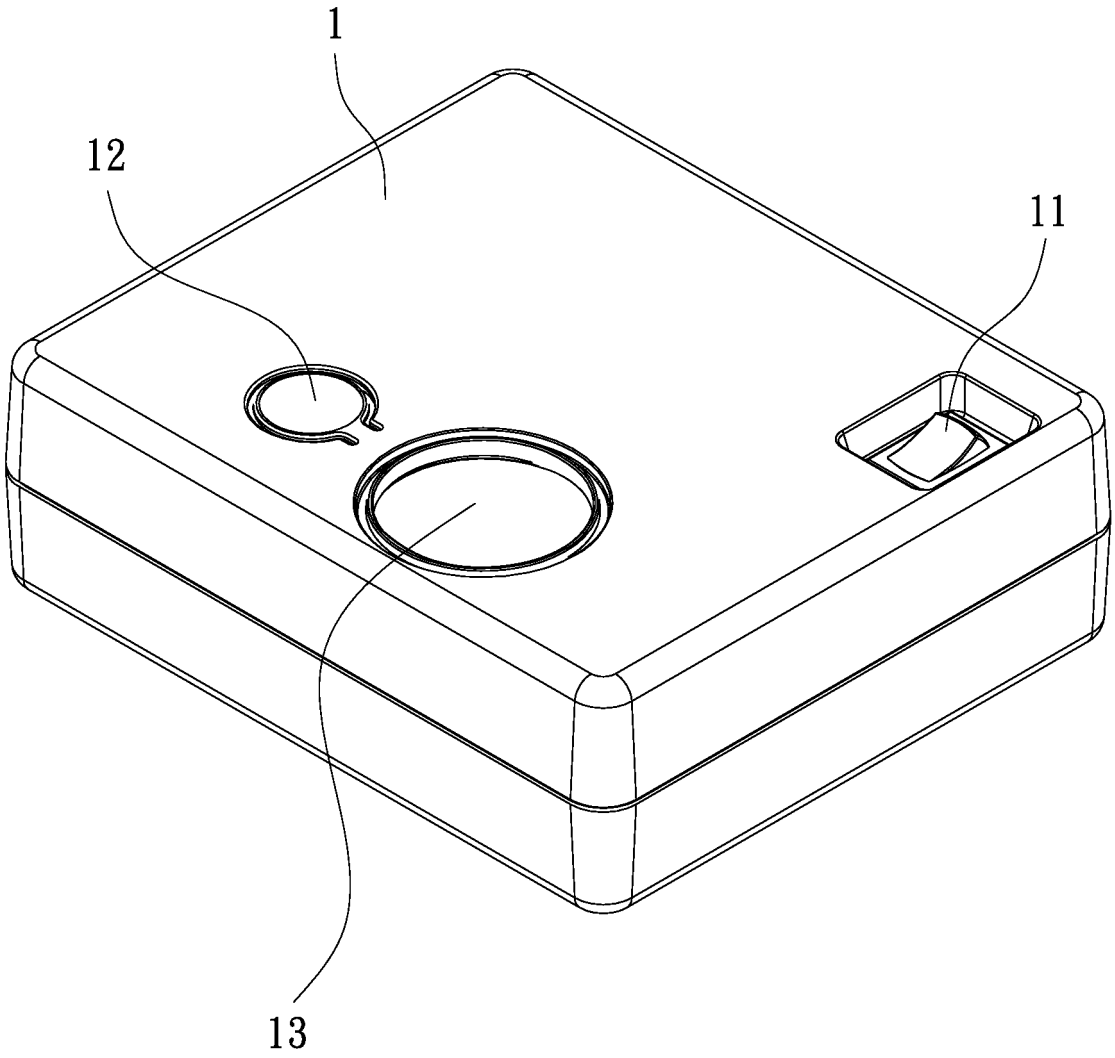

FIG. 1

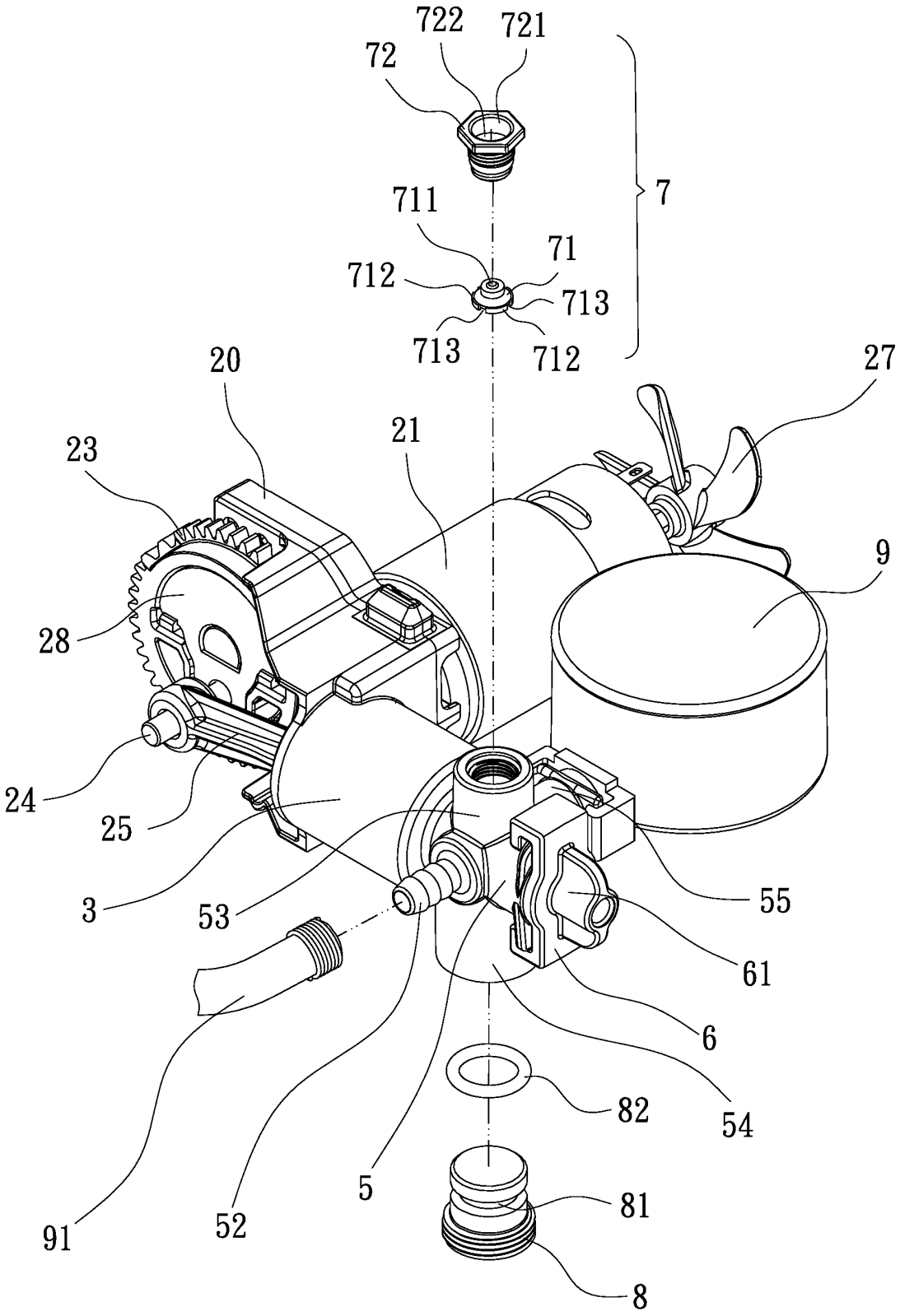
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FIG. 2

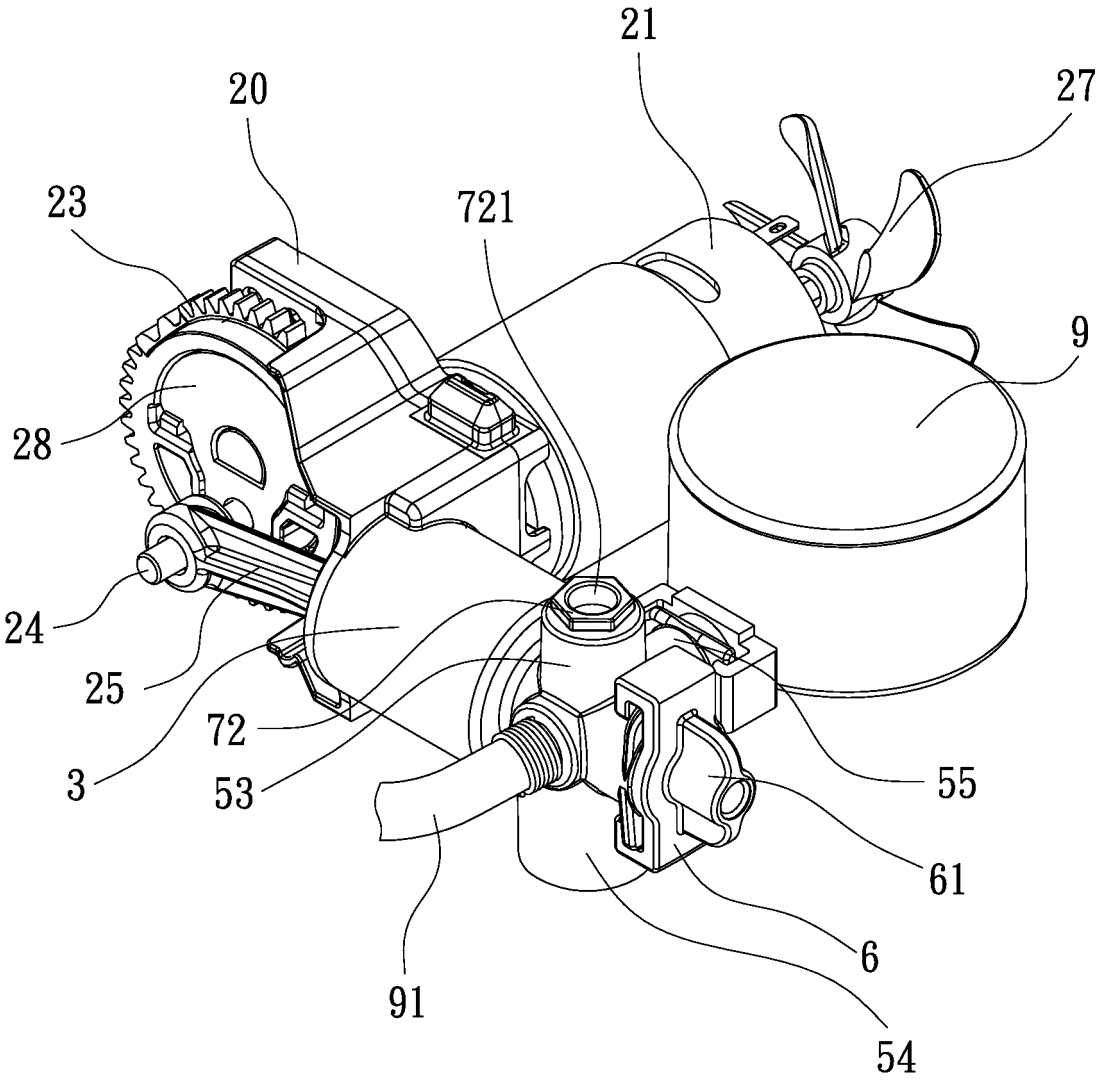

FIG. 3

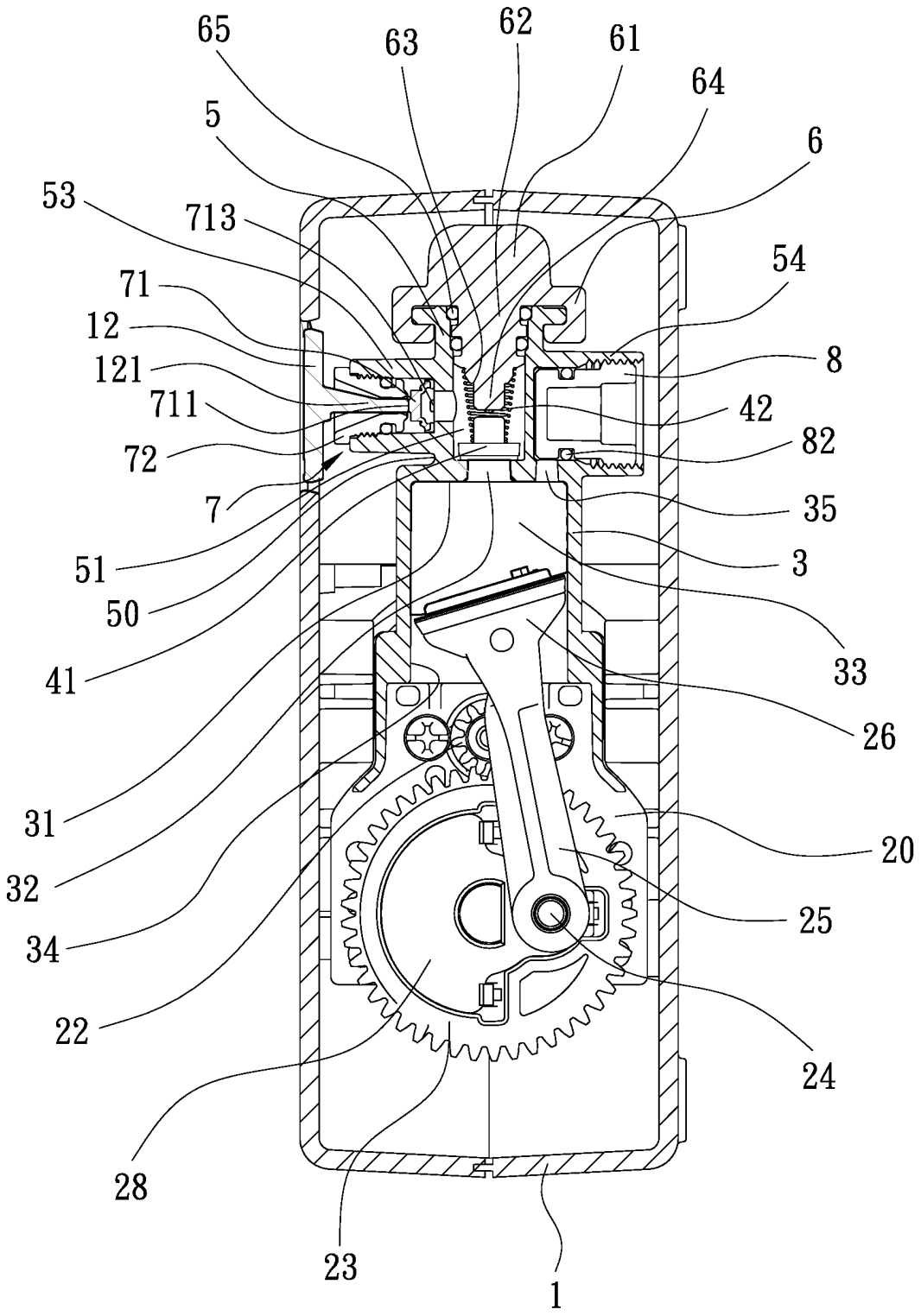
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FIG. 4

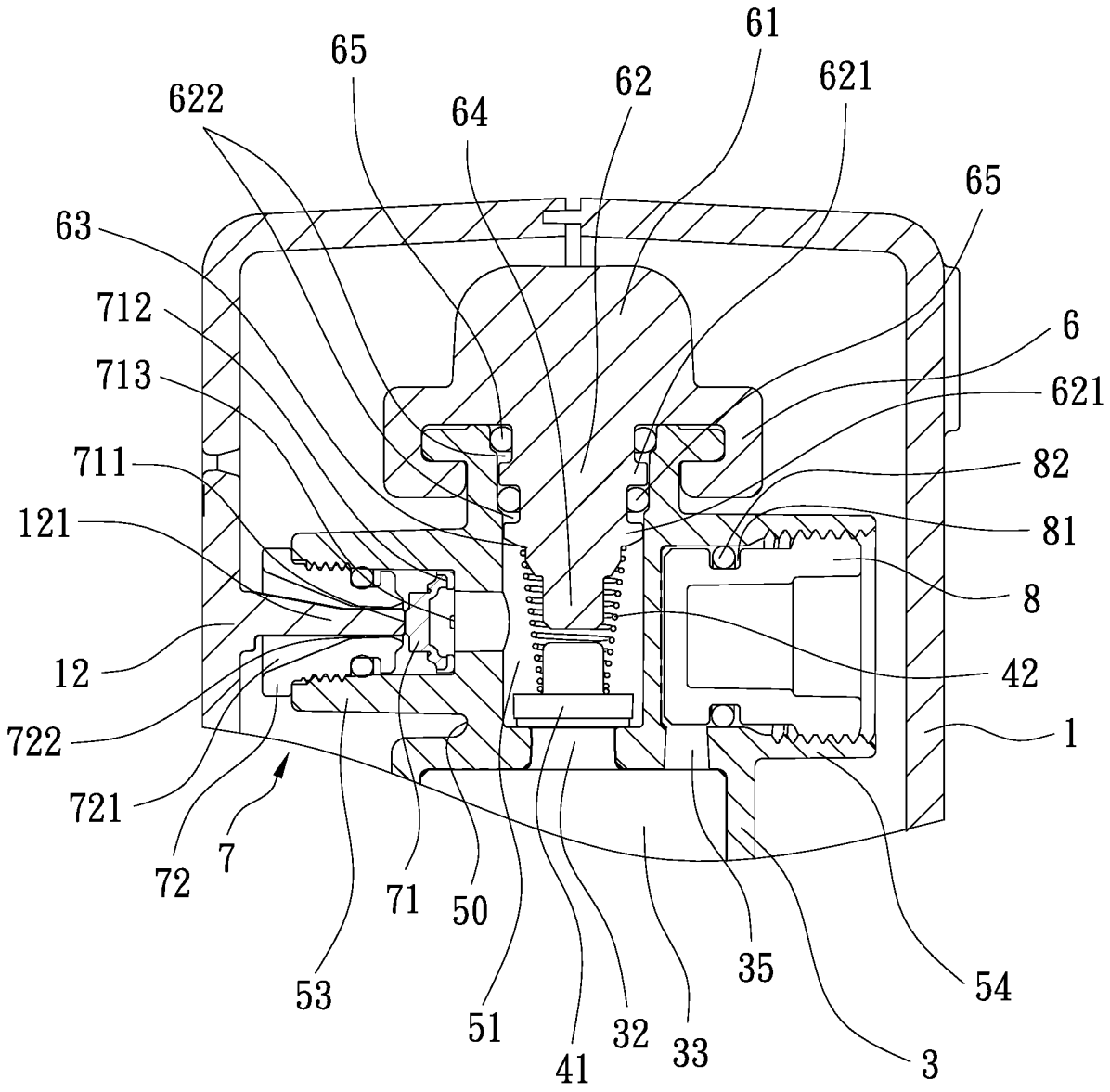
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FIG. 5

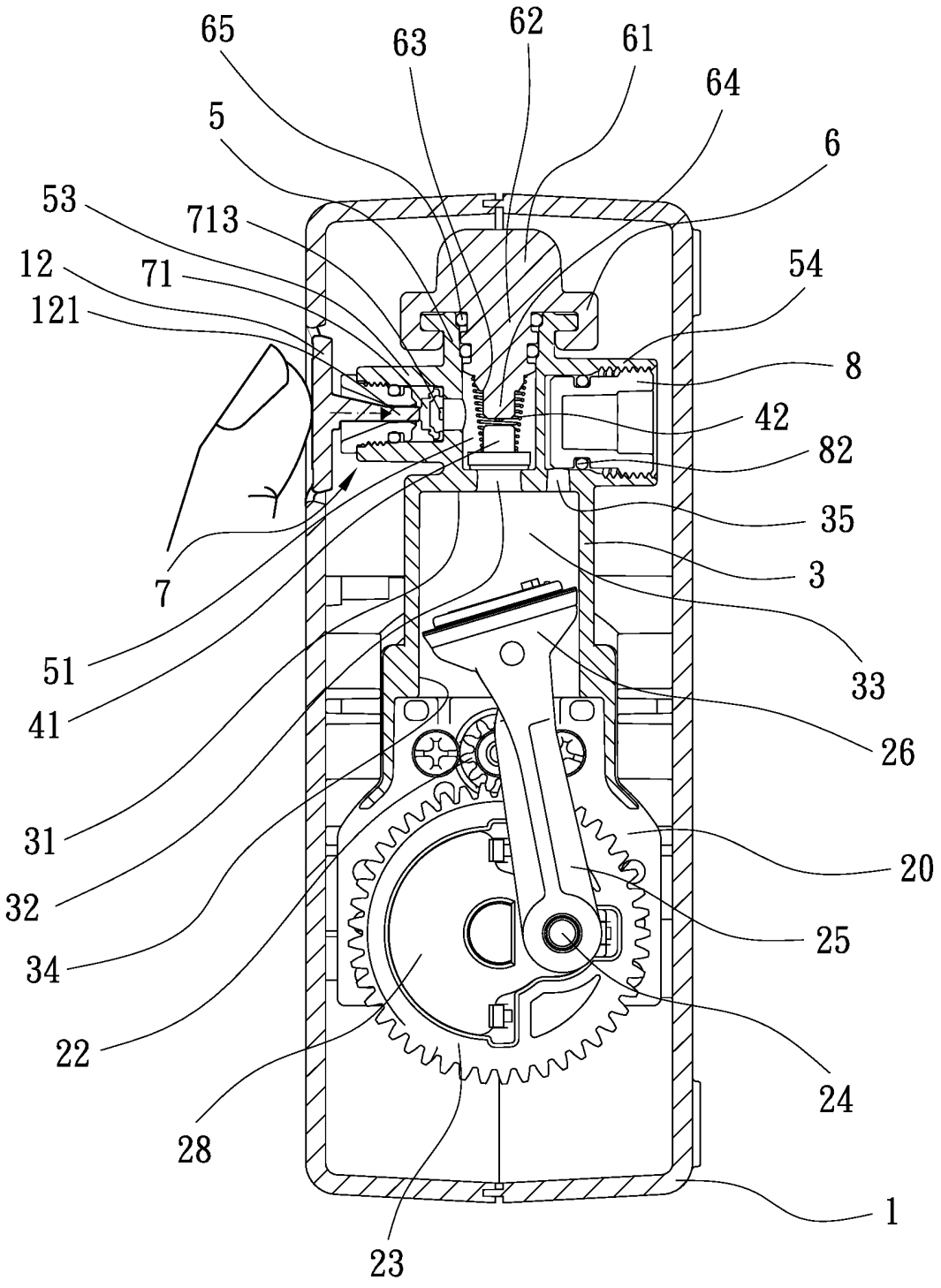
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FIG. 6

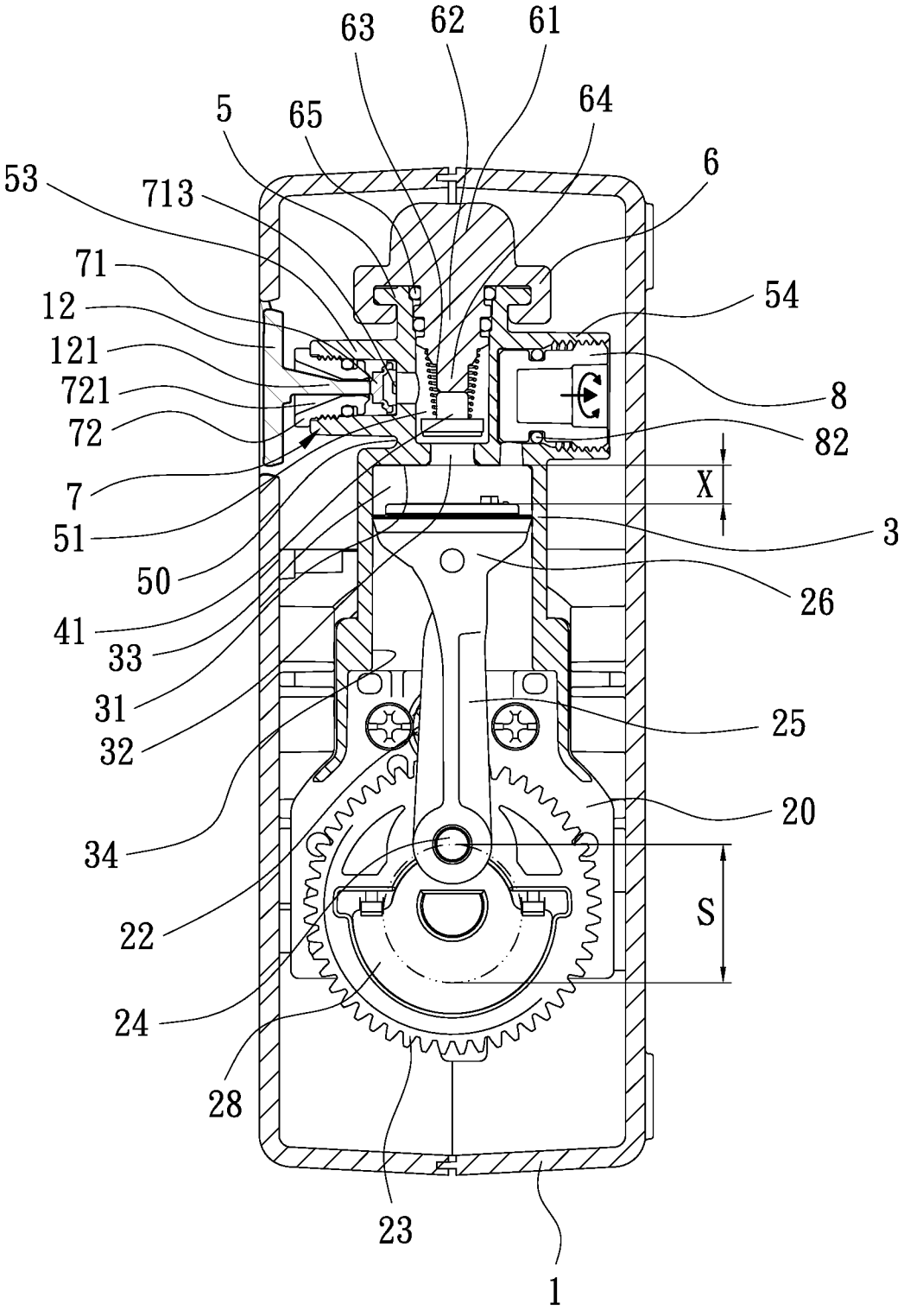
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FIG. 7

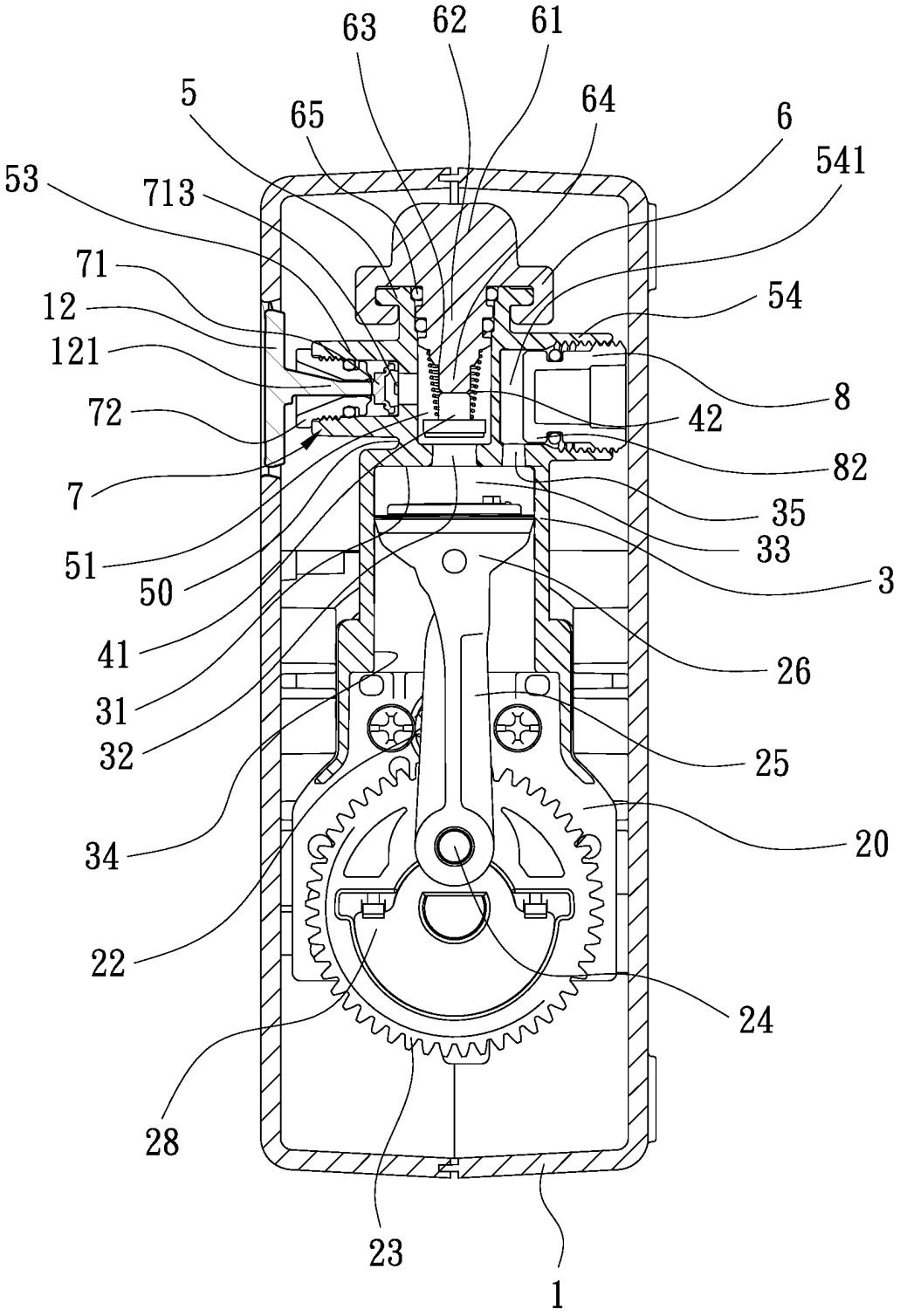
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FIG. 8

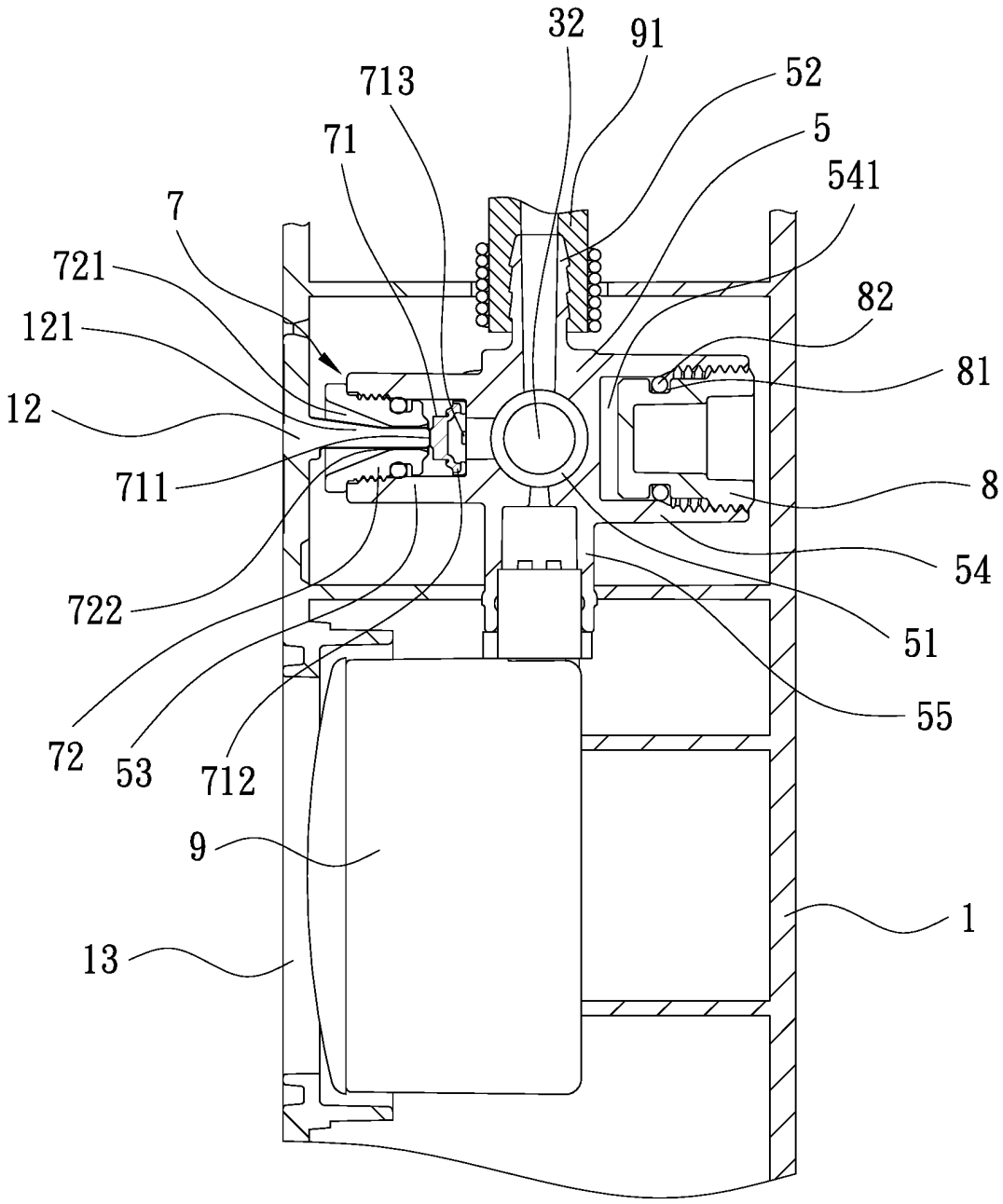
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FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2013/071535

A. CLASSIFICATION OF SUBJECT MATTER

See the extra sheet
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: F04B; F04C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNPAT, CNKI, WPI, EPODOC: compressor, piston, buffer, distance, space, spot

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN 101240783 A (ZHOU, Wensan) 13 August 2008 (13.08.2008) see description, page 5 and figure 2	1-4
Y	US 5655887 A (CHOU W) 12 August 1997 (12.08.1997) see description, columns 2 and 3 and figure 4A	1-4
A	CN 2349378 Y (ZHOU, Wensan) 17 November 1999 (17.11.1999) see the whole document	1-4
A	CN 1170827 A (TOYODA AUTOMATIC LOOM WORKS) 21 January 1998 (21.01.1998) see the whole document	1-4
A	CN 1030813 A (BRAUN ANTON) 01 February 1989 (01.02.1989) see the whole document	1-4
A	WO 2010000508 A1 (BOSCH GMBH ROBERT) 07 January 2010 (07.01.2010) see the whole document	1-4

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

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"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&"document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
04 November 2013 (04.11.2013)	21 November 2013 (21.11.2013)

Name and mailing address of the ISA	Authorized officer
State Intellectual Property Office of the P. R. China No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088, China Facsimile No. (86-10) 62019451	CHENG, Liang Telephone No. (86-10) 62085503

Form PCT/ISA /210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2013/071535

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 101240783 A	13.08.2008	CN 101240783 B	09.03.2011
US 5655887 A	12.08.1997	None	
CN 2349378 Y	17.11.1999	None	
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CN 1030813 A	01.02.1989	None	
WO 2010000508 A1	07.01.2010	DE 102008040040 A1	31.12.2009
		EP 2307725 A1	13.04.2011

Form PCT/ISA /210 (patent family annex) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2013/071535

Continuation of: second sheet

A. CLASSIFICATION OF SUBJECT MATTER

F04B 49/16 (2006.01) i

F04B 53/10 (2006.01) i

Form PCT/ISA /210 (extra sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 7462018 B **[0002]**