(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
9 December 2010 (09.12.2010)

PCT

(10) International Publication Number
WO 2010/141411 A1

(51) International Patent Classification:
F04B 33/00 (2006.01)

(21) International Application Number:
PCT/US2010/036813

(22) International Filing Date:
1 June 2010 (01.06.2010)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/183,811 3 June 2009 (03.06.2009) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report (Art. 21(3))*

(54) Title: GAS PUMP WITH LIMITING PRESSURE FEATURE

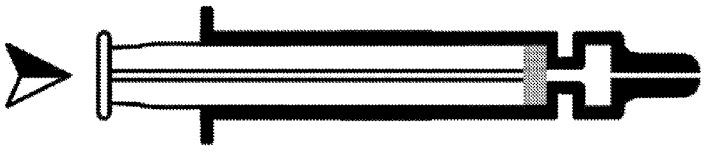

Fig. 3

(57) Abstract: A method, and apparatus for pressurizing a fillable-structure, wherein a space defined by the pump, an untraversed plunger, and a closure is a volume, V_t, and a stop to limit the travel of the plunger along the pump so a volume, V_b, remains within the space defined by the pump, the fully traversed plunger, and the closure. Traversal or manipulation of the plunger expresses gas from the pump to the fillable-structure wherein the pressurization of the fillable-structure is limited by the ratio of V_t to V_b whereby the fillable-structure can not be pressurized beyond a pressure P_{max}.

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GAS PUMP WITH LIMITING PRESSURE FEATURE

FIELD

[0001] The present invention relates to a gas pump comprising a stop mechanism wherein the stop mechanism limits the amount of pressure that can be inserted into a volume to be filled by a predetermined value. The present invention may be used to pump air, or other gasses, into structures such as inflatable toys, balloons, mattresses, rafts, and toys or other structures of fixed volume fillable by a gas.

BACKGROUND

[0002] The embodiments of the present invention described herein are directed towards a need that has not been addressed by previous implementations of air or gas pumps. Previous types of pumps do not adequately address scenarios where over-pumping can occur by an operator of a gas pump. Over-pumping may occur where the operator is unaware of the pressure at which a structure being filled with a gas will reach the upper limit of its structural integrity and rupture. Further, each relevant structure having a compartment fillable by a gas will vary in its tensile strength and ability to withstand pressure without rupturing. Alternatively, even where a structure does not rupture, its structural integrity may become so degraded by the pressure forces exerted upon it that it is no longer safe to use or may no longer have the ability to effectively serve its intended purpose.

Alternatively, it may be desirable to only have a specified limited pressurization in a fillable volume for a given purpose, in excess of which would be undesirable.

[0003] Accordingly, it is desirable to have a gas pump which will not allow the pump operator, or actuator, to cause over-pumping of a fillable structure. The present invention, disclosed herein, provides an efficient, cost-effective means for limiting the pressure that can be inserted into a volume to be filled by a predetermined value. Inflatable structures contemplated by this invention include, but are not limited to, inflatable toys, balloons, mattresses, rafts, and toys or other structures of fixed volume.

SUMMARY OF THE INVENTION

[0004] A method and apparatus for pumping gas into a fillable structure is provided featuring a pressure limiting feature, wherein the pump, a closure sealing a first opening of the pump at a first end having a one-way valve allowing only the egress of gas from the pump into a volume to be filled, a second opening on the pump at the opposite end, a plunger sealing the second opening and configured to slide along or traverse the pump and thereby express gas from the pump through the one-way valve, wherein a space defined by the pump, the fully traversed plunger, and the closure is a volume, V_t, and a stop to limit the travel of the plunger along the container so a volume, V_b, remains within the space defined by the container, the plunger, and the closure and the pressurization of the volume to be filled is limited by the ratio of V_t to V_b and the volume to be filled can not be pressurized beyond a pressure, P_{max}.

DRAWINGS

[0005] While the accompanying claims set forth features of an apparatus and method for limiting pressure as disclosed herein with particularity, embodiments of the device and method may be best understood from the following detailed description taken in conjunction with the accompanying drawings, of which:

[0006] FIG.1 illustrates a sectional view of a gas pump as exists in the prior art.

[0007] FIG.2 illustrates a sectional view of a pump with a limited pressure feature, as disclosed herein.

[0008] FIG. 3 illustrates a sectional view of a pump with a limited pressure feature, as disclosed herein, wherein the stop is comprised of a separation between two chambers of the pump.

DETAILED DESCRIPTION OF THE INVENTION

[0009] The present invention claims priority from United States Provisional Patent Application Serial No. 61/183,811, filed June 3, 2009, the contents of which are incorporated herein in their entirety by reference thereto.

[0010] Fig. 1 is a sectional view of a gas pump 100 as existing in the prior art. The apparatus comprises a pump 101 having a long axis and enclosing a volume of gas, V_t. A first opening 102 on said pump 101 is located at the first end of the long axis wherein said first opening 102 includes a one-way valve for the egress of gas from said pump 101 into a volume to be inflated. A second opening 103 is located on the opposite end of said pump 101. A plunger 104 sealing said second opening 103

is configured to slide along the long axis of the pump 101. The gas having volume V_t may be expressed from the pump through the one-way valve located at the first opening 102. Upon full traversal of the plunger 104 along the long axis of the pump 101, all the gas in volume V_t is expressed through the one-way valve located at the first opening 102. The target fillable structure substantially receives all of the gas expressed from the pump 101.

[0011] In instances where the gas pump 100 has a third opening located on the long axis of the pump 101, the third opening may have a one-way valve which allows the ingress of gas to said pump 101. As the operator, or actuator, retracts the plunger 104, the pump 101 having volume V_t fills again with gas. The source of the gas may be atmospheric, an external gas container, a compressor, or any other relevant means of providing gas thereto. The plunger 104 may then be manipulated again to express the entirety of the gas into the target fillable structure.

[0012] All possible target fillable structures have a maximum pressure value, P_{max}. P_{max} may be a function of the tensile strength of the materials comprising the fillable structure. If a fillable structure attains an internal pressure beyond P_{max}, then the structure may rupture. Even where the structure does not rupture, its structural integrity may become so degraded by the pressure forces exerted upon it that it no longer is either safe to use or may no longer have the ability to effectively serve its intended purpose. Alternatively, it may be desirable to have a limited amount of pressure in a fillable structure, where pressure in excess of the stated amount is undesirable.

[0013] Accordingly, over repeated manipulations of the plunger 104, or even a single manipulation, the target fillable structure may attain an internal pressure which is in excess of the ideal pressure, P_{max}, recommended for that particular structure. Theoretically, through over-pumping, the internal pressure of the gas inside the fillable structure can approach infinity. As stated, over-pumping may lead to rupturing of the fillable structure or, alternatively, conditions which are dangerous or negatively impact the utility of the fillable structure. This result is undesirable.

[0014] As disclosed in Fig. 2, the present invention improves upon the prior art and solves the problems caused by over-pumping by implementing a stop 205 to create a buffer zone having a volume V_b. In a preferred embodiment, the stop 205 is a ribbing or molding extruding from a fixed location on the interior of the pump 201. However, the stop 205 may be comprised of any suitable means capable of limiting the travel distance of the plunger 204. In a first alternative embodiment, the stop 205 is a post. In a second alternative embodiment, the stop 205 comprises a separation of two chambers of the pump 201. In a further alternative embodiment, the stop 205 may be slidable along the long axis of the pump 201 through an adjustment means accessible to the operator, or actuator, to achieve an ideal allocation of volume V_b.

[0015] The stop 205 operates to limit the distance along the long axis of the pump 201 that the plunger 204 can travel. The buffer zone is the volume of gas present in between the location of the stop 205, across which the plunger 204 cannot travel,

and the first opening 202. Whereupon the plunger 204 has fully traversed the long axis of the pump 201, the gas comprising volume V_t, less volume V_b, may be expressed into the target fillable structure.

[0016] The stop 205 must be located at an ideal position within the pump 201 in view of P_{max}. The ideal location of the stop 205 (i.e. the necessary volume of the buffer zone, V_b) may be determined by the following equation:

$$V_b = (V_t P_0) / P_{max}$$

[0017] The above equation assumes an ideal system, wherein no heat transfers to or from the environment of the pump and its components occurs. In the above equation, V_b is the desired volume of the buffer zone to be determined; V_t is the total volume of the pump 201; P_0 is the initial pressure of the gas within volume V_t; and P_{max} is the maximum pressure, or ideal pressure, of the target fillable structure, dependent upon the specifications and intended use of the structure. Accordingly, the stop 205 is positioned along the long axis, adjacent to the first opening as offset by volume V_b of the pump 201. If, however, it is desirable to have an operator, or actuator, perform multiple manipulations of the plunger 204, then the position of stop 205 may be adjusted accordingly, preserving the ratio between V_t and V_b. Furthermore, where practical considerations of scale between the pump 201 and the target fillable structure require, the ratio between V_t and V_b may be adjusted accordingly.

[0018] Manipulation of the plunger 204 may cause several different scenarios. The first instance is the "initial state," the target fillable structure having a

maximum pressure value of P_{max}, contains no gas and the plunger 204 has not yet been manipulated. Manipulation of the plunger 204 will result in the entirety of the gas comprising volume V_t, less the volume comprising volume V_b, to be expressed to the target fillable structure. However, if the pressure of the gas within the target fillable structure is equal to or greater than P_{max} during manipulation or traversal of the plunger 204, or upon full manipulation or traversal of the plunger 204, then the pressure within volume V_b will equal P_{max} and no further gas will be expressed into the fillable structure. Accordingly, the present invention limits the pressure of the gas in the fillable structure to not exceed maximum compressed air pressure, or P_{max}, by the ratio of the total volume of the pump, V_t, to the volume of the buffering zone, V_b.

[0019] In a second instance, a gas is already present in the target fillable structure and the pressure of the gas within the structure has not yet exceeded P_{max}. Here, the operator, or actuator, may continue to pump until the pressure of the target fillable structure equals P_{max}, whereupon further pumping will not be possible, as described above. Accordingly, the problem in the prior art of possible over-pumping is addressed by the present invention.

[0020] It should be appreciated by those of skill in the art that the configuration and shape of the pump 201 may take several forms, including, but not limited to, a hand-pump, a foot-pump, a box-pump, a circular pump, or an oval pump. Accordingly, pumps envisioned by the present invention may not have a long axis. Further, a pump may be constructed of any suitable rigid or flexible material. In

instances where a flexible material is used, the plunger may be the actual structure of the pump being compressed or traversed. Accordingly, it is to be appreciated that the embodiments discussed are exemplary and not limiting in the construction of the invention disclosed herein.

CLAIMS

What is claimed is:

1. An apparatus for the pressurization of a container with a gas comprising:

a pump;

a closure sealing a first opening on the pump at a first end having a one-way valve allowing only the egress of gas from the pump into the container;

a second opening on the pump at the opposite end;

a plunger sealing the second opening of the pump and configured to slide from the opposite end of the pump towards the closure and thereby express the gas from the pump through the one-way valve into the container, wherein a space defined by the pump, the uncompressed plunger, and the closure is a volume, V_t; and

a stop to limit the travel of the plunger along the pump so a volume, V_b, remains within the space defined by the pump, the fully traversed plunger, and the closure.

2. The apparatus according to claim 1, wherein the stop is a rib inside the pump.

3. The apparatus according to claim 1, wherein the stop is a post inside the pump.

4. The apparatus according to claim 1, wherein the stop is comprised of a separation between two chambers of the pump.

5. The apparatus according to claim 1, where $V_t / V_b > 1.0$.

6. The apparatus according to claim 1, where V_t / V_b is between 0.5 and 2.0.

7. The apparatus according to claim 1, where V_t / V_b is equal to 1.0.

8. The apparatus according to claim 1, where V_t / V_b is between 2.0 and 4.0.

9. The apparatus according to claim 1, wherein a third opening on the pump is located on the exterior perimeter of the pump having a one-way valve allowing only the ingress of gas to the pump.

10. The apparatus according to claim 1, wherein the container is a fixed volume.

11. The apparatus according to claim 1, wherein the container is an inflatable volume.

12. A method for pressurizing a container comprising the steps of:

providing a container to be pressurized up to a pressure, P_{max};

providing a pump, the pump having a closure at a first opening on the pump at a first end having a one-way valve allowing only the egress of gas from the pump into the container and a second opening on the pump at the opposite end;

sliding the plunger along the pump and thereby expressing gas from the pump through the one-way valve, wherein the space defined by the pump, the uncompressed plunger, and the first opening is a volume, V_t, and wherein traversal of the plunger along the pump to pressurize the container is limited by a stop such that a volume, V_b, remains within the space defined by the pump, the fully traversed plunger and the closure and the pressurization of the container is limited by the ratio of V_t to V_b whereby the container can not be pressurized beyond a pressure, P_{max}.

13. The method of claim 12, wherein the stop is a rib inside the pump.

14. The method of claim 12, wherein the stop is a post inside the pump.

15. The method of claim 12, wherein the stop is comprised of a separation between two chambers of the pump.

16. The method of claim 12, where $V_t / V_b > 1.0$.

17. The method of claim 12, where V_t / V_b is between 0.5 and 2.0.

18. The method of claim 12, where V_t / V_b is equal to 1.0.

19. The method of claim 12, where V_t / V_b is between 2.0 and 4.0.

20. The method of claim 12, wherein a third opening on the pump is located on the exterior perimeter of the pump having a one-way valve allowing only the ingress of gas to the pump.

21. The method of claim 12, wherein the container is a fixed volume.

22. The method of claim 12, wherein the container is an inflatable volume.

23. A method for pressurizing a container comprising the steps of:

providing a container of fixed volume to be pressurized up to a pressure, P_{max};

providing a pump having a, the pump having a closure at a first opening on the pump at a first end having a one-way valve allowing only the egress of gas from the pump into the container and a second opening on the pump at the opposite end;

sliding the plunger along the pump and thereby expressing gas from the pump through the one-way valve, wherein the space defined by the pump, the uncompressed plunger, and the first opening is a volume, V_t, and wherein traversal of the plunger along the pump to pressurize the container is limited by a stop such that a volume, V_b, remains within the space defined by the pump, the fully

traversed plunger and the closure and the pressurization of the container is limited by the ratio of V_t to V_b whereby the container can not be pressurized beyond a pressure, P_{max}.

24. The method of claim 23, wherein the stop is a rib.

25. The method of claim 23, wherein the stop is a post inside the pump.

26. The method of claim 23, wherein the stop is comprised of a separation between two chambers of the pump.

27. The method of claim 23, where $V_t / V_b > 1.0$.

28. The method of claim 23, where V_t / V_b is between 0.5 and 2.0.

29. The method of claim 23, where V_t / V_b is equal to 1.0.

30. The method of claim 23, where V_t / V_b is between 2.0 and 4.0.

31. The method of claim 23, wherein a third opening on the pump is located on the exterior perimeter of the pump having a one-way valve allowing only the ingress of gas to the pump.

Fig. 1

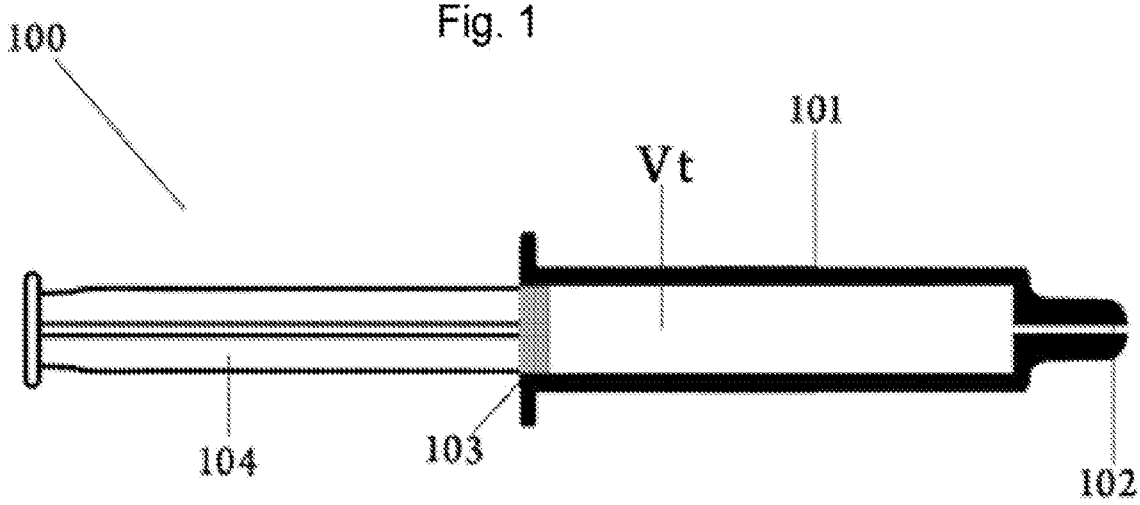

Fig. 2

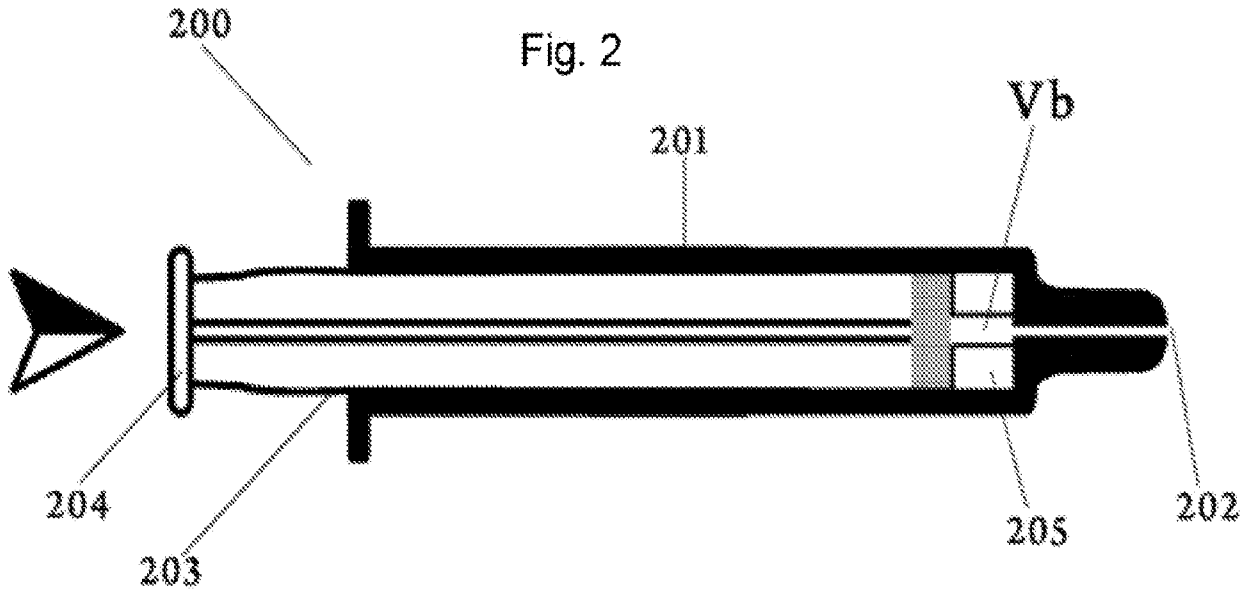

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 10/36813

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - F04B 33/00 (2010.01)
USPC - 417/547; 92/172
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(8) -- F04B 33/00 (2010.01)
USPC -- 417/547; 92/172

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
IPC(8) -- F04B$ (2010.01)
USPC -- 417/259

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PubWest (PGPB,USPT,USOC,EPAB,JPAB); USPTO; Espacenet; Google Patents; Google Scholar; Google -- please see extra sheet

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 2006/0154758 A1 (Laliberty et al.) 13 July 2006 (13.07.2006) Fig 1; Fig 3; Fig 4; Fig 6; Fig 7; Fig 8; Fig 9; Fig 10; para [0036]; [0042]; [0046]; [0050]; [0053]; [0059]	1,5,9,11 --- 2-4,6-8,10,20,22,31
X --- Y	US 3,888,347 A (Kramer) 10 June 1975 (10.06.1975) Fig 1; col 2, ln 31-51; col 3, ln 36-41	12-14,16,21,23-25,27 --- 2,3,10,15,17-19,20,22,26,28-30,31
Y	US 4,782,831 A (Gallant) 08 November 1988 (08.11.1988) Fig 1; col 1, ln 6-8; col 3, ln 19-45; col 5, ln 11-30; col 5, ln 52-58	4,6-8,15,17-19,26,28-30

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"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
13 July 2010 (13.07.2010)	29 JUL 2010
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 10/36813

Search Terms Used:

AIR BALL BUFFER$ CHAMBER CYLINDER EXCEED$ EXCESS$ FOOT HAND HAND-OPERATED HANDPUMP$ HAND-PUMP$ INFLAT$ LIMIT$ MANUAL MANUALLY MAXIMUM OVERPRESSUR$ OVER-PRESSUR$ OVERINFLAT$ OVER-INFLAT$ PRESSUR$ PREVENT$ PISTON PLUNG PLUNGER PUMP$ RECOMMENDED REMAIN$ SAFE STOP$ TIRE TOY VOLUME