# PLUNGERLIFT

# Introduction

Artificial lift systems "Plunger Lift", commercialized by SOTEC, benefit from the well's natural energy or administer its implementation with compressed gas on the surface (combination plunger lift – gas lift) providing a highly profitable method of artificial lift in a wide variety of applications and conditions, going from the onloading of gas wells' liquid to increase its production to the production of oil wells with insufficient gas flow or bottom hole pressure.

Our moving plunger lift systems are easy to maintain and environmentally friendly.

We have a complete range of compatible components, including pistons of all kinds, bottom springs with all anchoring modalities used in the industry, oilers, controllers and accessories.

As an integral part of our surface control package, the advanced controllers are able to operate in a fully automated way, combining all the pressures and times involved in the system's operating cycle. SOTEC's complete family of piston lifting products and our unparalleled technical assistance capacity on the ground guarantee that the systems are compatible and adapt to their reservoirs and are of exceptional economic value and operational efficiency.

# Advantages of Sotec systems:

- High efficiency systems, with the best control of lifting costs, with a fully integrated product package with the best technical support and application analysis software of Plunger Lift in the European industry.
- A large variety of drawings of moving plungers, including solid or rapid (by-pass), cleaning body, turbulent seal, positive seal, rotary, long for combinations with gas lift installations, large diameters and special drawings that adjust to the particular needs of the client.
- A complete family of surface controllers and programs specially designed for each major version of the system, in english, development of programs or special algorithms according to the unique needs of a particular new application.
- Proven performance of each application with low maintenance and optimization costs.
- The best engineering support applied to the industry system, more than 28 years of experience developing Plunger Lift.

# Scopes of the system:

- The choice or decision to install PL system is usually oriented to wells with the following characteristics:
- Gas wells that begin to accumulate liquid in the bottomhole
- Wells with a high Gaz-Liquid Ratio (GLR) that affects the current extraction system.
- Surging wells to which you want to improve the bottom pressure or decrease the gas-liquid ratio (GLR).
- Wells that are producing by intermittent gas lift and seek to optimize the consumption of injected gas and improve the production of liquid.
- Wells that are producing by means of continuous or intermittent gas lift and that have problems of deposition of paraffins or inlays of salts.
- Wells in which it is desired to reuse the extraction system in other wells of better production and that have sufficient characteristics of their own to operate with PL or available surface gas.
- Wells in which it is very difficult to apply another extraction system because they are diverted, very deep, high liquid gas ratio, etc.

# Bottomhole devices

SOTEC produces with high quality steels widely used in the hydrocarbon industry a large variety of specially designed bottomhole devices for every need, these include Collar stop, Tubing stop, G stop, bottom springs with anchors for each type of existing API device (the most used, cup anchors for nipples N-11, F, X, A, etc, anchor Latch Assembly, mechanic anchors), intermediate devices for multistage systems (two or more simultaneous pistons, also called progressive system).

# Collar Stop

Anchoring device for spring or end of stroke. Fixation in the space between pipe threads upset or non API standard upset.

Body and locking jaws made of steel SAE 4140 hardened and tempered. Surface treatment: chemical passivation or nickel – electroless casing.

# Tubing Stop

Anchoring device for spring or end of stroke. Fixation by means of clamps in any point of the inner wall of any pipeline, whether or not API.

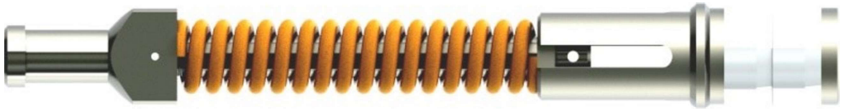
Body and locking jaws made of steel SAE 4140, nitrided, chemical passivated surface treatment or nickel – electroless casing.

# *Spring combined with* Collar Stop

Anchoring device for spring or end of stroke. Fixation in the space between pipe threads upset or non API standard upset.

Body and locking jaws made of steel SAE 4140 hardened and tempered. Surface treatment: chemical passivation or nickel – electroless casing.

# *Spring anchoring cup*



Bottomhole spring with integrated cups holder, is fixed on niples type “N-11”, “A”, “F”, “X” etc API standard.

Fishing head, rod and steel mandrel SAE 4140. Surface treatment: chemical passivation or nickel – electroless casing.

# Anchor *Spring Lower Lock*

Bottomhole spring with integrated lower locking anchor (latch down), it is fixed on API standard fishing heads.

Fishing head and steel rod SAE 4140, steel lower body SAE 4140B. Surface treatment: chemical passivation or nickel – electroless casing.

# *Modular Spring*

Bottom spring with threated integrated lower module, it supports all available anchor modules that can be fixed in standard API anchoring devices.

Fishing head, rod and lower steel body SAE 4140. Surface treatment: chemical passivation or nickel – electroless casing.

# Cup Holder Module for modular spring

Cup holder module to combine with modular spring, it fixes in nipples type “N-11”, “A”, “F”, “X” etc. API standard. Can be ordered with standing valve. Steel body SAE 4140 and Teflon anchor cups. Surface treatment: chemical passivation or nickel – electroless casing.

# *Latch Down module for modular spring*

Lower locking anchor module (latch down) to combine with modular spring, steel body SAE 4140B.

Surface treatment: chemical passivation or nickel – electroless casing.

# Latch Down Module with gasket and check valve for modular spring

Lower locking anchor module (latch down) with exterior gasket and check valve to combine with modular spring. Use in intermediate devices in multiple or progressive piston systems.

Steel body AISI 316L, steel lock SAE 4140B, gasket cup available in NBR, HNBR or Viton.

Surface treatment: chemical passivation or nickel – electroless casing.

## *Intermediate assembled device*

This device is the conjunction of "Modular Spring – lower anchor module (latch down) with exterior gasket and check valve – Tubing Stop – Modular Spring".

Its function is the limit of stroke for the lower and upper pistons and the retention of high liquids by the lower piston.

# Pistons (moving plungers)

SOTEC manufactures with steels and high quality materials, extensively used in the hydrocarbons industry, a large variety of pistons specially designed for every need; these include solid, rapid, continuous flow, multibody lengths to be used especially in gas lift installations, all of these of dynamic seal type. It also manufactures pistons with by-pass (fast) of positive seal type (quasi-static) in small and large diameters.

# *Solid Pistons*

They are the most used worldwide, extremely reliable for their simplicity and monoblock condition, its limits of use are marked by the flow to be produced (approx. 10m3/d) combined with the depth and viscosity of the fluid to be produced.

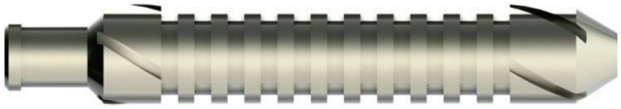
They are manufactured in three large groups, grooved turbulent seal drawing, drawing of pads (simple and double) or drawing with helical cleaning brush of synthetic material. The most used is the first of these groups.

- *Turbulent solid seal plunger (spiral plunger)*

Turbulent labyrinth seal plunger (high Reynolds number in the ring flow). It is manufactured in a single SAE 4140 steel block without heat treatment.

Surface treatment: chemical passivation or nickel – electroless casing.

- *Turbulent rotary solid seal plunger (spiral plunger)*



Turbulent rotary labyrinth seal plunger (high Reynolds number in the ring flow). Specially designed for even wear throughout its diameter when used in directed wells. Manufactured in a single SAE 4140 steel block without heat treatment.

Surface treatment: chemical passivation or nickel – electroless casing.

- Long *Turbulent solid seal plunger (spiral plunger)*

Long turbulent seal plunger (high Reynolds number in the ring flow). Specially designed for wells producing paraffinic oils. Manufactured in a single SAE 4140 steel block without heat treatment.

Surface treatment: chemical passivation or nickel – electroless casing.

- Long *Turbulent rotary solid seal plunger (spiral plunger)*

Long turbulent rotary seal plunger (high Reynolds number in the ring flow). Specially designed for directed wells and producers of paraffinic oils. Manufactured in a single SAE 4140 steel block without heat treatment.

Surface treatment: chemical passivation or nickel – electroless casing.

- *Turbulent solid seal plunger with dual pads (dual pad)*

Turbulent labyrinth seal plunger with dual pads. Specially designed for wells with some restriction in their ID below drift. Manufactured in SAE 4140 steel without thermal treatment with floating pads on springs.

Surface treatment: chemical passivation or nickel – electroless casing

## - *Turbulent solid brush-seal plunger*

Turbulent brush-seal plunger. Specially designed for wells containing solids of small granulometry, and for wells that present some small deformation in the production column decreasing the drift. Manufactured in SAE 4140 steel and containing in its middle part a helical brush built with 0.20 mm Ø fibers resistant to high temperatures and acid attack, supported by a stainless steel core. Without thermal treatment, surface treatment of chemical passivated steel or nickel – electroless casing.

## - *Plunger for combination in intermittent gas-lift installation*

Turbulent labyrinth seal plunger specially designed for wells with intermittent gas lift installations, non-conventional mandrels with side pockets for calibrated gas injection valve anchoring. These pistons are armed on a bar of alloy of Titanium grade 5; the set is armed with fishing heads and lower part made of SAE 4140 steel. Being able to carry 2 or 3 brush bodies, or 2 bodies with pads, or 2 Teflon bodies. Without thermal treatment, chemical passivated surface treatment.

# *Rapid Pistons (by-pass)*

These pistons are designed to work with large production volumes, great depths or oils of medium high viscosity. They have a central valve that opens when it is reached by the lubricator and closes when the piston leans on the bottom spring, this enables a central passage of large area facilitating the transit of fluids from the base of the piston to the top, considerably increasing their speed of descent.
The use of this type of piston has been able to produce up to 100 m3 / d from a depth of 2300 meters. Per tube of 2 7/8".

## *- Turbulent fast piston seal*

Turbulent labyrinth fast travel piston seal (high Reynolds number in the annular flow). Specially designed for oil wells with high production values (liquid and / or gas), great depths, producers of viscous oils and gas wells with production values below the critical flow.

Manufactured in SAE 4140 steel without heat treatment.

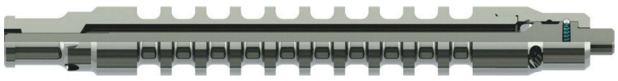
Surface treatment: chemical passivation.

## - *Turbulent rapid piston seal with dual pads*

Turbulent labyrinth fast travel piston seal (high Reynolds number in the annular flow). Specially designed for oil wells with high production values (liquid and / or gas), great depths, producers of viscous oils and gas wells with production values below the critical flow, that present some restriction in their ID below the drift.

Manufactured in SAE 4140 steel without heat treatment, chemical passivated surface treatment or nickel casing.

## - Long *Turbulent rapid piston seal*



Turbulent labyrinth fast travel piston seal (high Reynolds number in the annular flow). Specially designed for oil wells with high production values (liquid and / or gas), great depths, producers of viscous and / or paraffinic oils, as well as for gas wells with values of production below the critical flow.

Manufactured in SAE 4140 steel without heat treatment, chemical passivated surface treatment.

## - Long *turbulent rotary rapid piston seal*

Turbulent labyrinth fast travel piston seal (high Reynolds number in the annular flow). Specially designed for oil wells with high production values (liquid and / or gas), great depths, producers of viscous and / or paraffinic oils, as well as for gas wells with values of production below the critical flow; that have some severe deviation in their production column.

Manufactured in SAE 4140 steel without heat treatment, chemical passivated surface treatment.

## - *Turbulent rapid brush-seal plunger*

Turbulent labyrinth fast travel piston seal (high Reynolds number in the annular flow). Specially designed for wells containing solids of small granulometry, and for wells that present some small deformation in the production column decreasing the drift. For wells with high values of production (liquids and / or gas), great depths, producers of viscous oils, as for gas wells with production values below the critical flow. Manufactured in SAE 4140 steel and containing in its middle part a helical brush built with 0.20 mm Ø fibers resistant to high temperatures and acid attack, supported by a stainless steel core.
Surface treatment: chemical passivation.

## - *Turbulent rapid piston seal of continuous flow*

Turbulent labyrinth fast travel piston seal (high Reynolds number in the annular flow).

Specially designed for gas wells with high production values below the critical flow and great depths; as well as for oil wells producing extremely viscous oils.

These pistons are hollow with a by-pass valve in their lower part, the actuator of this valve is contained in the lid of the lubricator.

Manufactured in SAE 4140 steel without heat treatment, chemical passivated surface treatment or nickel casing.

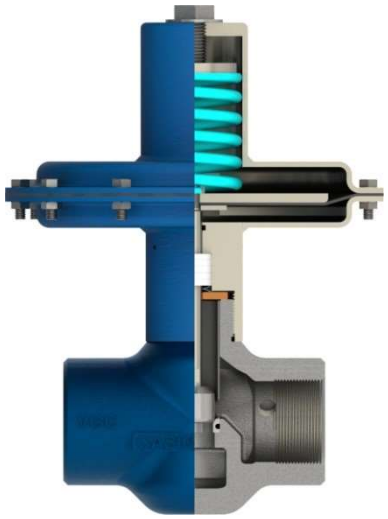
## - Positive seal *piston (small diameter)*

Positive seal piston by means of cups manufactured in NBR or Buna (synthetic rubber, acrylonitrile copolymer (ACN) and butadiene), resistant to acids, hydrocarbons and temperatures up to 120°c. They are also manufactured in Viton (fluoroelastomer) with high qualities in resistance to the attack of acids, aromatic hydrocarbons, and temperatures up to 220°. Its body is made of SAE 4140 and AISI 420 steel.

## - *Positive seal piston (large diameter)*

Positive seal piston by means of cups manufactured in NBR or Buna (synthetic rubber, acrylonitrile copolymer (ACN) and butadiene), resistant to acids, hydrocarbons and temperatures up to 120°c. The cups are also manufactured in Viton (fluoroelastomer) with high qualities in resistance to the attack of acids, aromatic hydrocarbons, and temperatures up to 220°. Its body is made of SAE 4140 and AISI 420 steel.

# Globe valve with pneumatic control



SOTEC manufactures the Model VGC-4000 valves used by the system (plunger lift) for the operation of the well. The bodies are molten in SAE 4140 steel, which have a working pressure of 4000 psi, they are subjected to hydraulic testing in an all in accordance with the standard "ASME Sect. VIII Division 1 UG-99" with a pressure of 6000 psi. It has female threaded connections in 2 "NPT (11.5 f.p.p.).

The diaphragm case is stamped in 4mm carbon steel plate. It has a mechanical position indicator (open – closed).

AISI-316L steel shutter shaft, teflon packing multi-V or Teflon-NBR O'ring.

Set of seat and shutter available in normal hardness and high hardness for handling suspended solids.

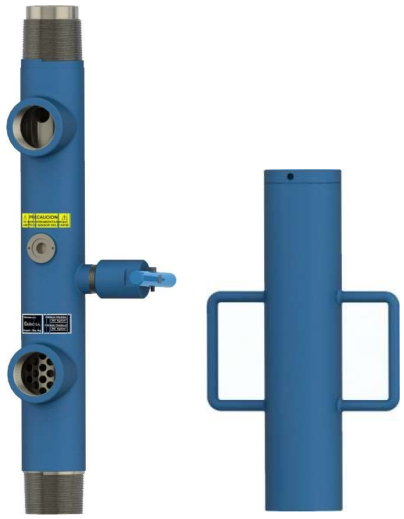
# Separator set (condenser) and regulator for instrument gas

SOTEC manufactures and assembles the separator sets and regulator used by the system (plunger lift) for the supply of instrument gas under suitable conditions and pressure.

The separators are built in steel tubes ASTM-A53 or 106 schedulle 160, which have a pressure of work of 3000 psi, are subjected to hydraulic testing in an all in accordance with the standard "ASME Sect. VIII Division 1 UG-99 "with a pressure of 4500 psi. It has female threaded connections in 1/4 “NPT (18 f.p.p.).

The regulator is of national industry and is apt to regulate from up to 3000 psi to 30/40 psi, which is the pressure used by controllers and pneumatic valves.

# Small diameter lubricators



Lubricators are devices that allow the piston to stop at the end of the ascending run (they must have an adequate damping system), provide housing for the piston detection system (sensor) and allow the piston to be trapped for inspection or replacement due to exhaustion of its useful life.

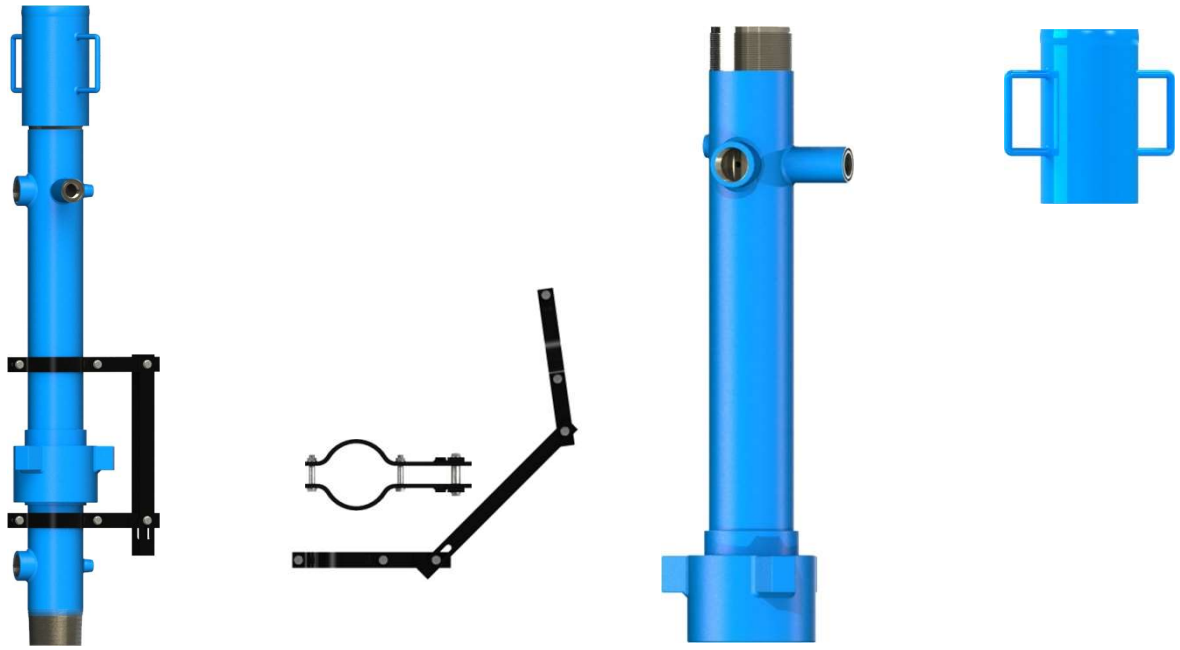
SOTEC's lubricators have a system of hydro pneumatic and mechanical damping that allows to stop the piston in any case without damage to it or to the lubricator.

The body of the lubricator is made of SAE 4140 steel (central tube), SAE 1036 on all threaded or flanged connections and AISI 316 steel in the arrival sensor housing. All lubricators have double production output and admit any of the pistons that SOTEC manufactures.

All welds have certified procedures and are made by qualified and certified welders.

The lubricators are subjected to a hydraulic test in all in accordance with the standard "ASME Sect. Division 1 UG-99" with a pressure of 6000 psi. They are suitable to operate with up to 4000 psi.

# Large diameter lubricators



Lubricators are devices that allow the piston to stop at the end of the ascending run (they must have an adequate damping system), provide accomodation for the piston detection system (sensor) and allow to trap the piston for inspection or replacement due to exhaustion of its useful life.

The large diameter lubricators brand SOTEC have a hydropneumatic and mechanical damping system which allows to stop the piston in any case without causing any damage to it or to the lubricator and a turning device that facilitates and makes safe the opening maneuver due to its important weight.

The body of the lubricator is made of steel SAE-4140 (center tube), SAE 1036 on all connections whether they are threaded or flanged and AISI 316 steel in the arrival sensor housing. All lubricators have double production output and admit any of the pistons SOTEC manufactures.

All welds have certified procedures and are performed by qualified and certified welders.

The lubricators are subjected to a hydraulic test all in accordance with the standard "ASME Sect. VIII Division 1 UG-99" with a pressure of 3000 psi. They are suitable to operate with up to 2000 psi. Upon request of the customer, SOTEC can manufacture these lubricators to work at pressures of up to 6000 psi.

# Wellhead electronic controllers

SOTEC has launched the line of own controllers. These models apply several programs for pressures and combined times, especially the use of differential pressures Sotec-Tubing or Tubing-Line that allow to optimally manage the available energy and the operation of the system. Controllers are timers with 4 operating modes, two basic and two self-adjusting in the modes of gas and oil.

The electronic controllers are state-of-the-art, with telemetry and telecontrol capabilities, with event memory that allows to store these and system operation parameters.

The electronic, the pressure transducers, the changeover solenoid valves and the battery accumulators are installed inside the metal container cabinet (can be made of steel with protection by epoxy enamel or stainless steel) which provides mechanical and electromagnetic protection to electronic components.

All the controllers can be configured with up to 3 pressure transducers (except some which supports 2 transducers) and up to 3 changeover solenoid valves.

They have specialized programs for each of the particular applications of the artificial lift system Plunger Lift, for autonomous wells (with enough gas or in excess for the system) in all modalities (pressures and time combined, differential pressure, load factor or only for fixed or self-adjusting times). As well as for reservoir oils that do not have enough gas for the operation of the system without the contribution of compressed gas on the surface, in which case the controllers that SOTEC sells have specialized programs for almost all types of surface gas assistance (combination Plunger Lift – Gas Lift).

All the programs are in English, using terms and abbreviations widely used in the industry. The mode of operation is extremely friendly with drop-down menu windows and a single command for navigation, selection and programming of parameters.

**Power supply**: Your power supply is a sealed lead acid battery of 6 VDC / 14 Amp-Hr, included inside the steel cabinet. The system can accept from 6 VDC to 12 VDC, a solar panel of 6 VDC / 3 W is sufficient to maintain the battery charge, since the controller consumes on average only 25 mA of current. However, during the operation of the changeover valves (solenoid valves), the system can consume up to 2 amps in periods of 50ms to 100 ms.

**Container**: A steel cabinet with enough robustness to support the weight of the components and the power supply. It has external connections for pressure measurement and instrument gas lines. A steel mounting bracket is firmly welded to the cabinet to allow it to be mounted on the flange of the valve in the wellhead or in the diaphragm-holder body of the pneumatic valve, directly to a tubular support by clamp. The carbon steel cabinet is protected with Powder Coating, it has a minimum classification of NEMA 4 norm, equipped with a full opening front door with an elastomer seal around the entire perimeter of this door.

It is also available in stainless steel.

**Connections**: The connectors for the lines of pressure and gas of instruments can be of Brass (brass) or stainless steel, they are normal connectors 1/4 "NPT to 7/16" fit for 1/4 "tubing.

**Memory**: It has 128 Mbits of flash memory for registers, 2 MBytes for program and 512 KBytes of RAM.

# Electro valves

***(To be installed inside the controller cabinet according to the chosen configuration)***

They are changeover valves of 3 ways with solenoid, consume energy only for the change of state. The operating gas of the motor valves is expelled out of the cabinet during their closure. This vent line is available for inspection by the operator to determine obstructions or damage. These solenoid valves can work up to 60 psi in the feed gas, however it is recommended to set the gas supply pressure for instruments at 30 psi.

# Pressure transducers

***(To be installed inside the controller cabinet according to the chosen configuration)***

They are the elements that capture the three possible physical pressures of the well and transform them into digital signals to be interpreted by the controller's electronics, showing the pressure values in real time on the display and using them for the operation of the system. They can have a reading range of up to 1000, 2000 or 5000 psi.

**Access**: For communication using Modbus it has an RS485 port and connectors labeled D + (B) 1, D- (A) 1 and GND for a RS-485 3-wire connection (half-duplex), allowing remote control and inspection of the control unit.

In addition to the RUN and STOP buttons there are three buttons that allow you to scroll through the menus, and make selections by pressing OK, this is also used to enter or modify values of time or pressure parameters.

**Display**: The controller contains a quartz display for climate up to -24oC (-10oF) of four lines of twenty characters with backlighting, shows the field operator the status or actions when programming and the status of the controller in the operation.

**Inputs**: The controller has a connection terminal block for the three pressure transducers, the three electrovalves, a piston arrival sensor, three AUX inputs and for the Solar Panel and battery connection.

There are additional connectors for future expansion.

**Weight**: The total weight of the controller with the battery is 7.25 Kg (16 lbs).

**Size**: The dimensions of the box are 272 mm Height x 175 mm Width x 145 mm Depth.

# Solar Panels

SOTEC complements the equipment with solar panels of 6 and 12V of the appropriate power for each use, of national industry brand Solartec, with its corresponding support to be mounted on the production bridge.

# Piston Arrival Sensors

SOTEC produces magnetic arrival sensors that can be used with any of the lubricators and controllers used in this artificial system.

Its body is made of PVC cross-linked (resistant to UV) and it is mounted with screws in the antimagnetic seats available in the lubricators.

It also imports wavefront sensors, called "Strap-on Sensor", of the brand Multi Products Co. These are mounted on any part of the body of the lubricator.

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