

Pressure Regulators

DIVAL 500

CE



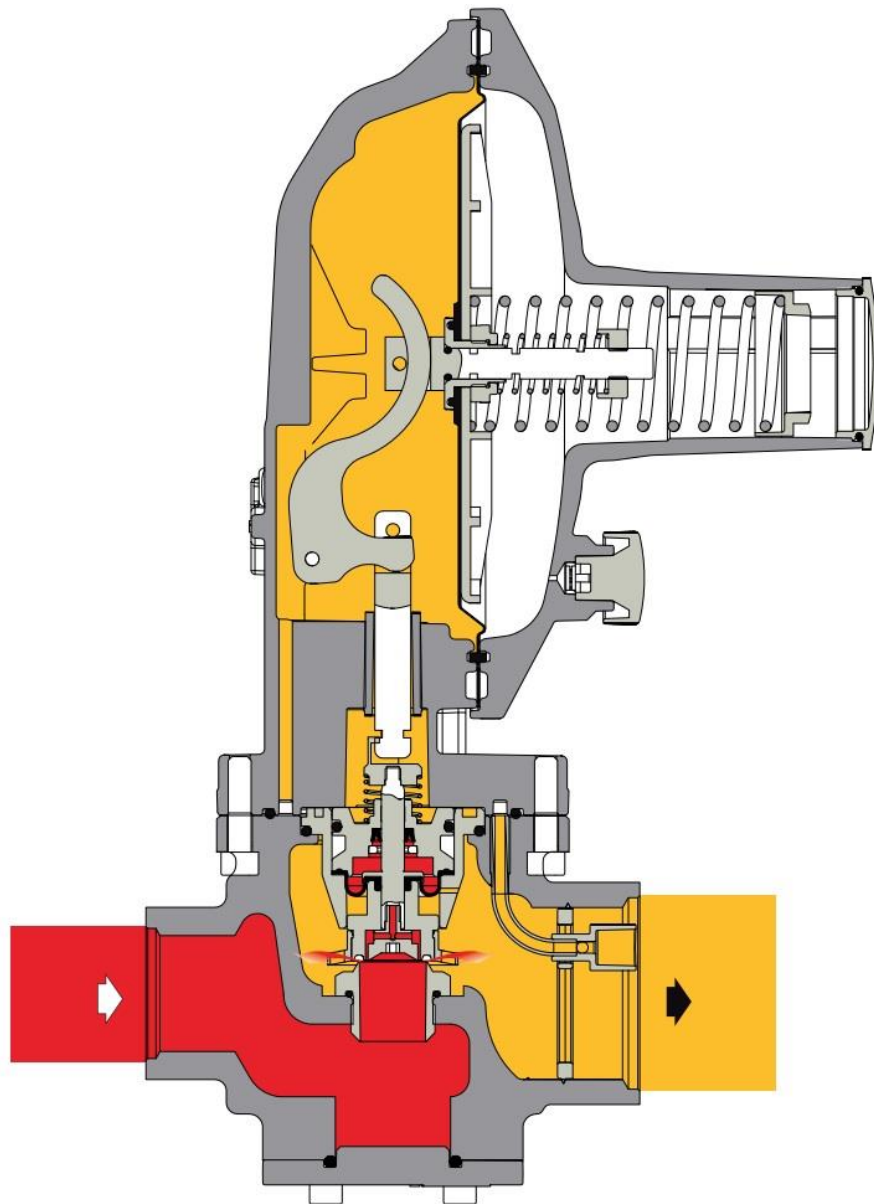
TECHNICAL MANUAL

 **Pietro
Fiorentini**

EN



DIVAL 500



DIVAL: Basic version



INLET PRESSURE

OUTLET PRESSURE



GENERAL WARNINGS

The equipment described in this manual is a device subject to pressure installed in systems under pressure. The involved equipment is usually embedded in systems conveying flammable gases (e.g. natural gas).

WARNINGS FOR THE OPERATORS

Before performing the installation, commissioning or maintenance, the operators must:

- go through the safety provisions applicable to the installation where they have to operate;
- obtain the necessary authorizations to operate, when required;
- be equipped with the necessary personal protective equipment (helmet, goggles, etc.)
- make sure that the area in which they have to operate is equipped with the required collective protections as well as with the necessary safety signs.

PACKAGING / TRANSPORT / STORAGE

The packaging materials used for transporting the equipment and the related spare parts have been designed and manufactured to avoid damages during normal transport, storage, and related handling. Therefore, the equipment and spare parts must be kept in their respective original packages till their installation in the final destination site. When the packages are opened, it is necessary to verify the integrity of the materials therein contained. In case of damages, report the detected damages to the suppliers preserving the original package to allow the performance of necessary inspections.

The storage of the equipment, even after its use, must occur in suitable places, free of moisture and away from sources of light and heat, within the limits stated on the rating plate

HANDLING

The handling of the equipment and its components must be performed after having established that the lifting means are suitable for the loads to be lifted (lifting capacity and functionality) in order to avoid bumps, impacts and local stresses.

When necessary, the handling of the equipment must be performed using the lifting points foreseen on the equipment itself. The use of motorized means is reserved to authorized personnel only.

INSTALLATION

The installation of the pressure regulator must occur in compliance with the provisions (laws or regulations) in force in the place of installation.

In detail, natural gas plants must show features complying with the law provisions or regulations in force in the place of installation or at least complying with the standards EN 12186 or EN 12279. The installation in compliance with such standards minimizes the risk of fire and the formation of potentially hazardous atmospheres.

The equipment is not provided with internal pressure limitation devices; therefore, it must be installed making sure that the operating pressure of the installation in which it is installed does not exceed the value of the allowable maximum pressure (**PS**).

The user shall therefore, when he/she deems it necessary,

provide for the installation on the assembly of suitable pressure limitation systems; Moreover, the user shall equip the plant with suitable relief or drain systems in order to be able to discharge the pressure and the fluid contained in the plant before proceeding with any inspection and maintenance activity.

Should the installation of the equipment require the installation on site of compression fittings, these latter have to be installed following the instructions provided by the manufacturer of the fittings. The selection of the fittings must be compatible with the use specified for the equipment and with the plant specifications, when foreseen.

COMMISSIONING

The commissioning must be carried out by **suitably trained personnel**.

During the commissioning, the personnel not strictly necessary must be kept away and the limited access area must be properly marked (signs, barriers, etc.).

Verify that the equipment calibrations are the ones required. If necessary, restore the required values for the same as provided for later on in this manual.

During the commissioning, the risks determined by any discharges to the atmosphere of flammable or noxious gases must be assessed.

For installation on natural gas distribution networks, it is necessary to consider the risk of formation of a (gas/air) explosive mix within the piping.

COMPLIANCE WITH DIRECTIVE 97/23/EC (PED)

The regulator **Dival 500** is classified as pressure accessory pursuant to Directive 97/23/EC (PED).

The regulator **Dival 500** with embedded slam-shut device and pressure switch tripping in case of maximum pressure is classified as safety accessory pursuant to the PED Directive and, therefore, it can be used as both a pressure accessory and a safety accessory, always pursuant to the PED Directive.

The configuration with active regulator and monitor regulator in line is defined as a safety accessory according to the PED Directive. In this case, the user is responsible for verifying that the allowable maximum pressure (**PS**) of the pressure equipment to be protected is compatible with the calibration of the monitor regulator and its lockup pressure class (**SG**).



1.0 INTRODUCTION

This manual aims at supplying essential information on the installation, commissioning, disassembly, re-assembly, and maintenance of the regulators **DIVAL 500** (fig. 1).

Moreover, it is deemed suitable to provide the reader with a brief description of the main features of the regulator and its accessories.

1.1 MAIN FEATURES

The pressure regulator **DIVAL 500** is a pressure regulator for previously cleaned gaseous fluids, suitable for low, medium and high pressure.

DIVAL 500 is a normally open regulator and, therefore, it opens in case of:

- breakage of the main membrane;
- lack of regulated pressure signal.

The main features of this regulator are:

- Design pressure **PS**: up to 20 bar
- Operating temperature: $-20\text{ °C} \div +60\text{ °C}$;
- Ambient temperature: $-20\text{ °C} \div +60\text{ °C}$;
- Range of the inlet pressure **bpu**: 0.2 to 20 bar
- Possible regulation range **Wd**:
 - ✓ $13 \div 100$ mbar for BP head;
 - ✓ $100 \div 300$ mbar for MP head;
 - ✓ $300 \div 2500$ mbar for TR head;
- Minimum differential pressure: 0.1 bar;
- Accuracy class **AC**: up to 5 (depending on the outlet pressure range).
- Range of the lockup pressure **SG**: up to 10 (depending on the outlet pressure range).

1.2 OPERATION OF THE REGULATOR DIVAL 500

In the absence of pressure and with loaded calibration spring, the obturator **211** is kept in the open position by the coupling of the stem **201** by the lever mechanisms **305**.

The outlet pressure P_d is controlled by the comparison between the load of the spring **328** and the thrust that the outlet pressure itself exerts on the membrane **322**.

Also the weight of the moving equipment and dynamic thrusts acting on the obturator are considered in this comparison.

The inlet pressure, although variable, does not affect the balance of the obturator **211**, since the same - given the presence of the hole **A** - finds itself between two equal pressures acting on equal surfaces.

The movement of the membrane **322** is transmitted by the lever system **305** to the stem **201** and, therefore, to the obturator **211**. The obturator is provided with a vulcanized rubber gasket in order to assure a perfect tightness when the requested flow rate is zero.

If during operation the outlet pressure P_d decreases, the thrust it exerts on the membrane **322** becomes lower than the load of the spring **328**; therefore, the membrane lowers, causing, through the levers **305**, the obturator **211** to move away from the valve seat **102**. Consequently, the gas flow rate increases until the initial calibration pressure value is restored.

If instead the outlet pressure starts to increase, the force exerted on the membrane **322** exceeds the load of the spring **328**. Therefore, the obturator is shifted toward the closed position, letting the outlet pressure return to the preset value.

Under normal operating conditions, the obturator **211** is positioned in such a way as to maintain the pressure P_d around the chosen calibration value. The calibration pressure can be adjusted by appropriately turning the internal adjustment ring nut **318** clockwise to increase it and counterclockwise to decrease it.

The solution described in fig. 3 is adopted in order to protect the obturator against damages resulting from sudden increases in the regulated pressure.

This solution allows, in fact, the membrane protection disc **323** to lean on the upper cover, thus overcoming the load of the spring **329**, thereby relieving the obturator from the load caused by the abrupt pressure increase.

To prevent small leakages - at requested zero flow rate or due to sudden and temporary overpressures resulting, for example, by abrupt maneuvers or gas overheating - from making the slam-shut valve trip, the solution of fig. 2 may be replaced, upon request, by an embedded relief valve, removing the O-rings (fig. 3).

Its operation occurs as follows: with closed regulator, any overpressures lift the membrane protection disc **323** overcoming the load of the springs **328** and **329**. In this way, a given quantity of gas is discharged through the seat **Z**.

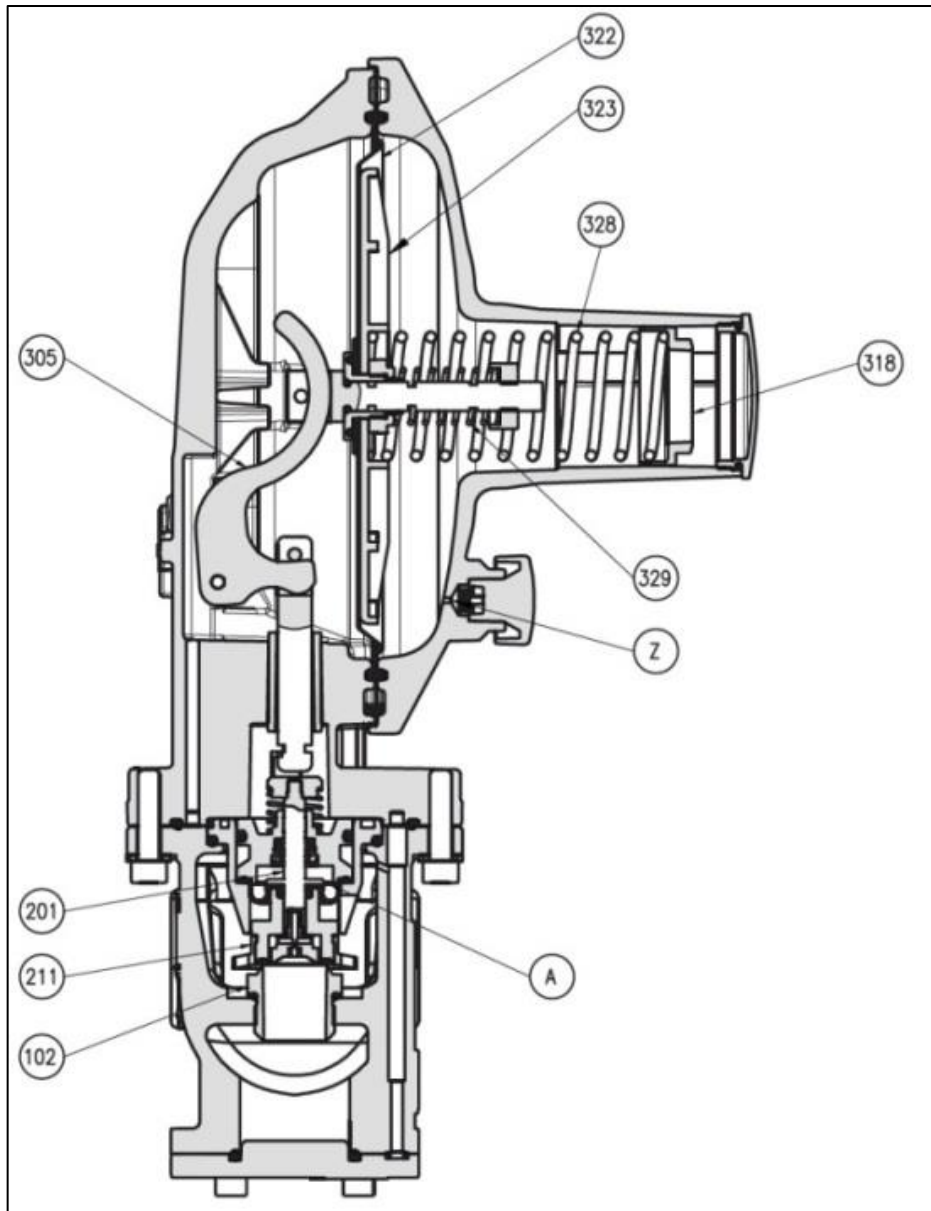


Figure 1: DIVAL 500

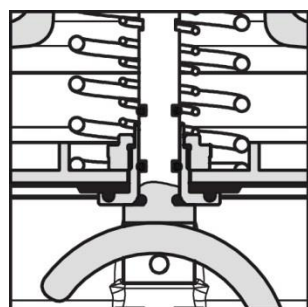


Figure 2: Relief version NO

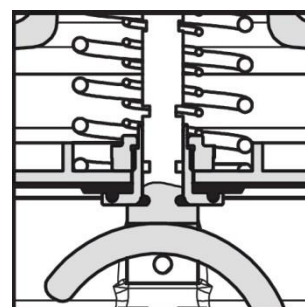


Figure 3: Relief version YES



1.3 CALIBRATION SPRINGS TO THE REGULATOR AND RELIEF

Table 1.1 shows the calibration ranges of the different available springs.

FEATURES OF THE SPRINGS FOR DIVAL 500 BP							
Pos.	Code	Color	d	Lo	De	N.	Calibration range (mbar)
1	64470137RO	RED	1,8	115	34	1	13 ÷ 17
	64470024BI	WHITE	1,3	45	15		
2	64470068GI	YELLOW	2	115	34	1	18 ÷ 24
	64470024BI	WHITE	1,3	45	15		
3	64470139NE	BLACK	2,2	115	34	1	25 ÷ 34
	64470024BI	WHITE	1,3	45	15		
4	64470140MA	BROWN	2,7	106	34	2	35 ÷ 64
	64470031RO	RED	1,7	40	15		
5	64470071GR	GREY	2,8	118	34	2	65 ÷ 100
	64470031RO	RED	1,7	40	15		

d = Ø wire Lo = Spring length De = Ø external N. = Spring Note

FEATURES OF THE SPRINGS FOR DIVAL 500 MP							
Pos.	Code	Color	d	Lo	De	N.	Calibration range (mbar)
1	64470141VE	GREEN	3,2	120	34	3	100 ÷ 169
	64470038GI	YELLOW	2	40	15		
2	64470329AZ	LIGHT BLUE	3,8	111	34	3	170 ÷ 300
	64470038GI	YELLOW	2	40	15		

d = Ø wire Lo = Spring length De = Ø external N. = Spring Note

FEATURES OF THE SPRINGS FOR DIVAL 507 / 512 TR							
Pos.	Codice	Colore	d	Lo	De	N.	Campo di taratura (mbar)
1	64470143BI	WHITE	4,5	97	34	4	300 ÷ 399
	64470040GR	GREY	1,5	44	15		
2	64470143BI	WHITE	4,5	97	34	5	400 ÷ 599
	64470038GI	YELLOW	2,	40	15		
3	64470144VI	PURPLE	5	100	34	5	600 ÷ 999
	64470038GI	YELLOW	2	40	15		
4	64470145AR	ORANGE	5,5	100	34	5	1000 ÷ 1199
	64470038GI	YELLOW	2,	40	15		
5	64470145AR	ORANGE	5,5	100	34	6	1200 ÷ 1799
	64470045MA	BROWN	2,4	41	15,3		
6	64470151BL	BLUE	6,5	100	34,5	6	1800 ÷ 2500
	64470045MA	BROWN	2,4	41	15,3		

d = Ø wire Lo = Spring length De = Ø external N. = Spring Note

Note:

- 1 - Spring code n° 64470024BI is for internal relief [Pd+(10÷17)]
- 2 - Spring code n° 64470031RO is for internal relief [Pd+(18÷50)]
- 3 - Spring code n° 64470038GI is for internal relief [Pd+(30÷100)]
- 4 - Spring code n° 64470040GR is for internal relief [Pd+(50÷95)]
- 5 - Spring code n° 64470038GI is for internal relief [Pd+(100÷259)]
- 6 - Spring code n° 64470045MA is for internal relief [Pd+(260÷699)]

2.0 INSTALLATION

2.1 GENERAL

The regulator does not require any additional safety device at inlet to assure protection against any overpressures with respect to its permissible pressure **PS** when, for the reducing station positioned at inlet, the maximum incidental outlet pressure is:

$$P_d \leq 1.1 \text{ PS.}$$

Before installing the regulator, it is necessary to make sure that:

- the regulator can be inserted in the forecast space and is sufficiently accessible for performing the following maintenance operations (see overall dimensions in table 2.1);
- the inlet and outlet pipings are on the same level and are able to support the regulator weight (see table 2.2);
- the inlet/outlet connections of the piping are parallel;
- the inlet/outlet connections of the regulator are clean and the regulator itself has not been subject to any damages during transport;
- the inlet piping has been cleaned in order to remove any residual impurities such as welding scraps, sand, paint residues, water, etc.

The normally forecast arrangement is the one shown in fig. 4; other possible installations are shown in fig. 5.

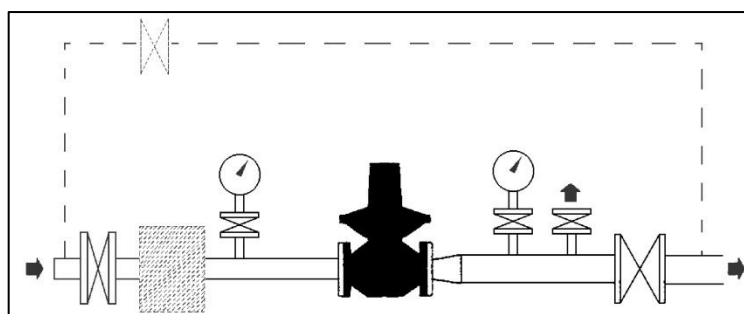


Figure 4

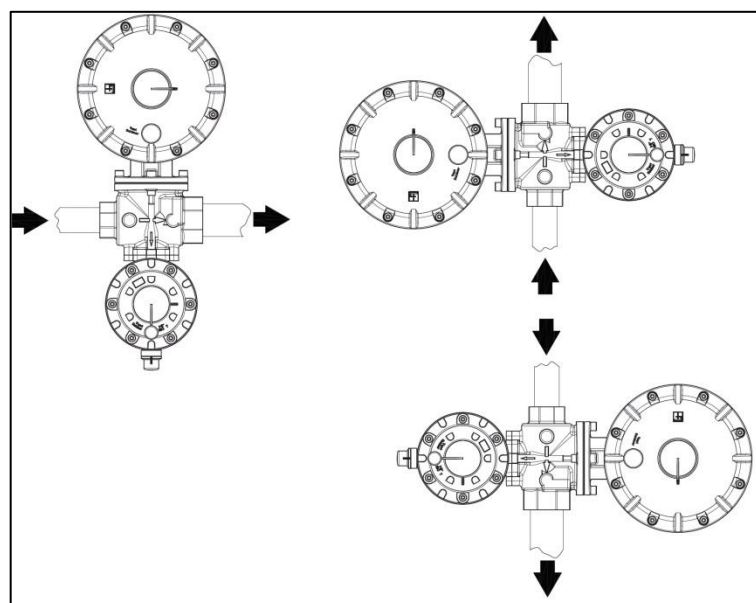


Figure 5



Table 2.1: Overall dimensions in mm (fig. 6)

Code	DN	NPS	A	B	C	D	E	F	M	N
DIVAL 500	25x25	1"x1"	100	255	44	185.5	//	173	Rp 1/4	//
DIVAL 500 + LA	25x25	1"x1"	110	255	182	185.5	161	173	Rp 1/4	Rp 1/4
DIVAL 500	25x40	1"x1 1/2"	130	257	55	185.5	//	173	Rp 1/4	//
DIVAL 500 + LA	25x40	1"x1 1/2"	130	257	182	185.5	161	173	Rp 1/4	Rp 1/4

Table 2.2: Weights in KGF

Code	DN	NPS	DIVAL 500	DIVAL 500 + LA
DIVAL 500	25x25	1"x1"	3.6	4.2
DIVAL 500	25x40	1"x1 1/2"	3.8	4.4

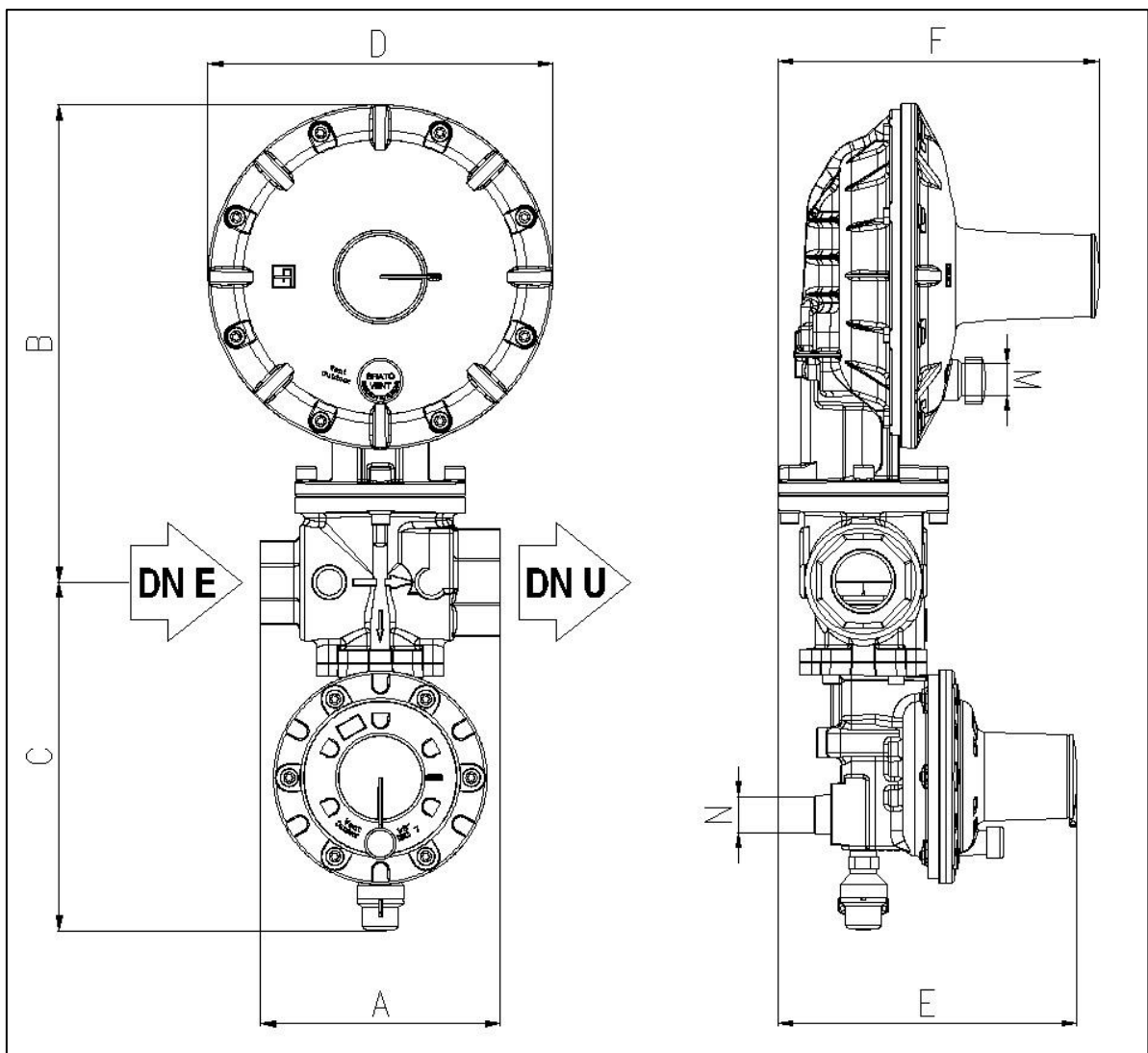


Figure 6: Overall dimensions

2.2 CONNECTING THE EQUIPMENT

The regulators series Dival 500 can be equipped with:

- internal sensing line.
- internal + external sensing line
- external sensing line (monitor version)

Where forecast, the connections between the equipment and the piping have to be carried out using a stainless steel or copper pipe, having a minimum internal diameter of 8 mm.

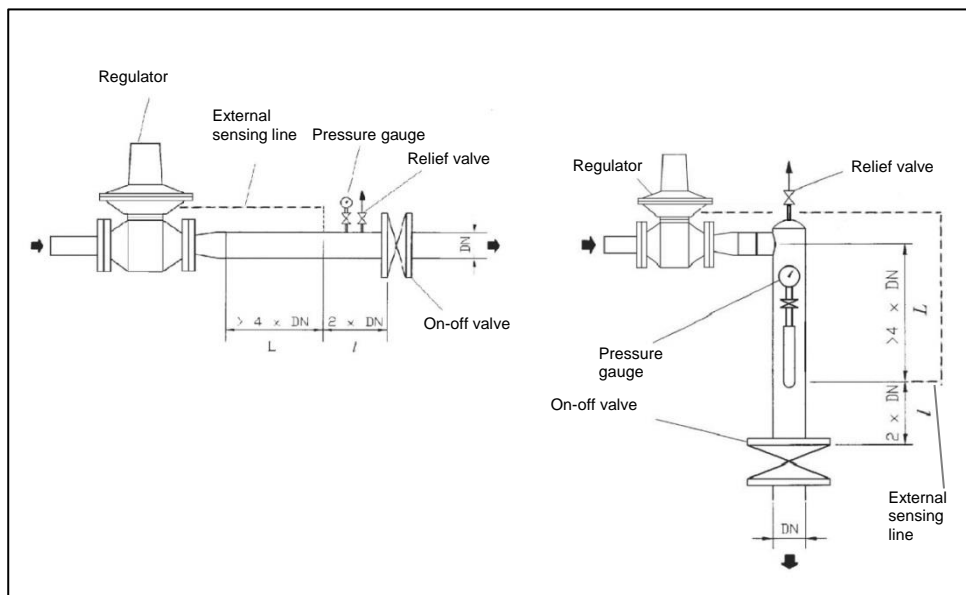


Figure 7: Installation diagram

The installation on a system with a multiple sensing connection point (fig. 8) aims at deriving from a single point all the pressure sensing signals reaching the various reduction and safety equipment and the related accessories.

The regulator must be installed in the line with the arrow on the body positioned in the gas flow direction.

Where forecast, in order to obtain a good regulation it is essential that the position of the outlet pressure sensing points and the gas speed at the sensing point meet the values given in table 2.3. When it is used in gas pressure reduction stations, the regulator shall be installed at least in compliance with the requirements of the EN 12186 or EN 12279 standards. All possible relief points due to any breakages of sensors/ membranes shall be conveyed in compliance with the EN 12186 or EN 12279 standards.

In order to prevent impurities and condensation from building up in the pressure sensing tubes, it is advisable to provide for the following:

- the tubes shall always be positioned on a descending slope towards the connection of the outlet piping with a slope of about 5 - 10%;
- tube branch connections shall always be welded on the upper part of the piping itself and the hole on the piping shall not show any burrs or projections towards the internal side.

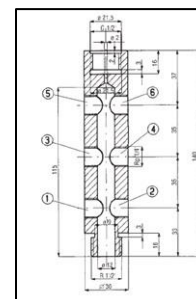


Figure 8

To avoid breakages or unwanted deformations, it is recommended to provide for the following:

- the equipment shall be installed pursuant to the regulations in force and the good practice
- there shall not be any external loads acting on the device
- the equipment shall be provided with adequate protection and grounding means to protect it against stray currents and electrostatic potential differentials
- the equipment shall be used within the limits set on the rating plate

Table 2.3

In the regulator outlet piping, gas speed shall not exceed the following values:
$V_{max} = 25 \text{ m/s}$ for $1.5 < P_d < 5 \text{ bar}$
$V_{max} = 20 \text{ m/s}$ for $0.5 < P_d < 1.5 \text{ bar}$
$V_{max} = 15 \text{ m/s}$ for $P_d \leq 0.5 \text{ bar}$

2.3 DOWNSTREAM VOLUME REQUIRED FOR INSTALLATION

When using the regulator with ON-OFF service (stopping and starting of the burners), it should be noted that although the device **DIVAL 500** is classified as "rapid reaction" type, it requires a given gas volume between the device itself and the burner, **suitably sized** (at least **1/500 of the nominal flow rate for pressures up to 300 mbar, 1/1000 for higher pressures**), in order to partly absorb the pressure swings caused by rapid changes in the flow rate.

3.0 MODULARITY

The modular concept of the regulators series **DIVAL 500** assures the possibility of applying the slam-shut valve to the same body without changing its alignment, even after the installation of the regulator.

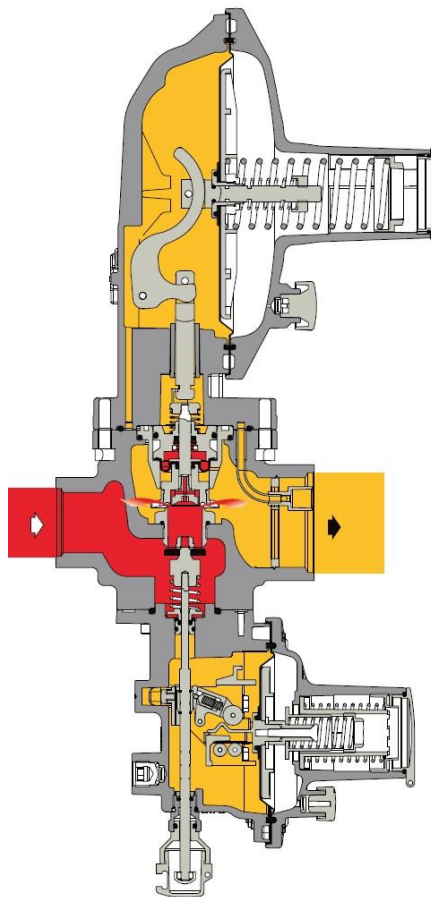
3.1 EMBEDDED SLAM-SHUT VALVE LA/...

It is a device (fig. 9) that immediately blocks the gas flow, if - due to any failures - the outlet pressure reaches the value preset for its tripping.

For the pressure regulator DIVAL 500, it is possible to have the slam-shut valve embedded on both the active regulator and on the one acting as monitor in line. Three versions are available (LA/BP, LA/MP and LA/TR), depending on the tripping pressure ranges.

The main characteristics of this slam-shut device are the following:

- allowable maximum pressure **PS**: up to 20 bar;
- tripping due to pressure increase and/or decrease;
- accuracy **AG**: up to $\pm 5\%$ on the calibration value for pressure increase (depending on the calibration pressure); up to $\pm 15\%$ for pressure decrease (depending on the calibration pressure);
- internal by-pass device;



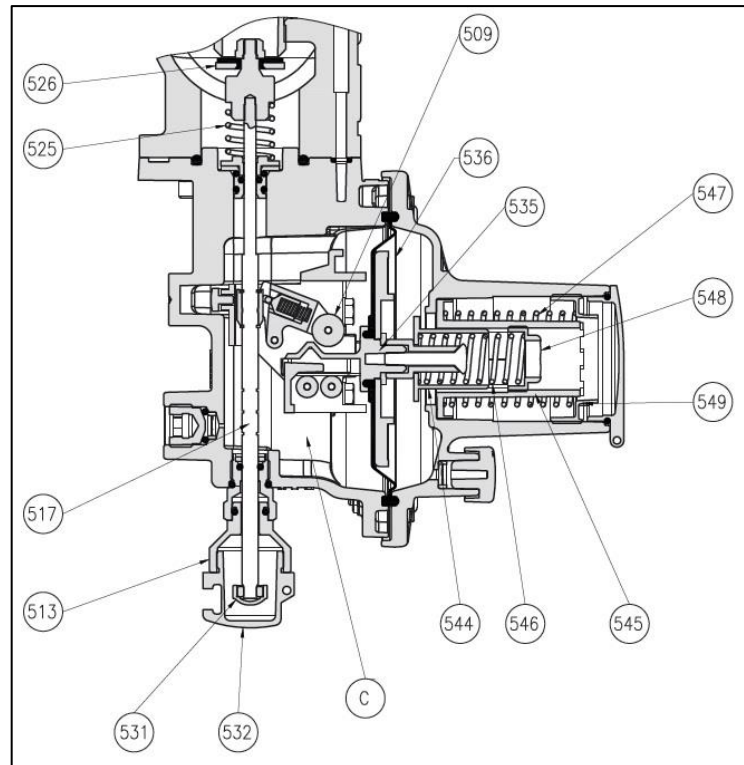


Figure 9: Slam-Shut Device LA

The slam-shut valve LA/.. (fig. 9), tripping in case of minimum and maximum pressure, is essentially made up of an obturator mounted on a stem, a release lever mechanism, a control head and a manual restoration system. In the chamber **C** of the control head, the pressure to be controlled P_d acts on the membrane **536**, which is integral with the shaft provided with cam **535**.

The load of the pressure P_d on the membrane is opposed by the springs **546** and **547**, which cause, respectively, the tripping due to increase or decrease in the pressure. The calibration of the device is performed by acting on the ring nuts **548** and **549**. A clockwise rotation of the ring nuts results in an increase in the tripping value; vice versa in case of counterclockwise rotation. In case of tripping due to pressure increase, when the pressure P_d exceeds the calibration value, the load on the membrane **536** increases until it overcomes the resistance of the spring **547**. This causes the movement of the shaft **535**, which - by means of the cam - moves the touch probe **509** thus releasing the lever mechanism. In this way, the stem **517** is freed and the obturator **526** is made to close by the spring **525**. The tripping due to pressure decrease instead occurs as follows.

As long as the pressure value P_d remains above the calibration load of the spring **546**, the spring support **544** remains leaning on the support **545**.

If the pressure P_d decreases below the pre-set value, the spring **546** makes the support **544** and consequently the shaft **535** move.

Consequently, the cam moves the touch probe **509** causing the release of the lever mechanism.

The restoration of the block occurs by pulling the bushing **531** until the lever mechanism is coupled again.

During the first stage of the maneuver, it is necessary to wait until the upstream pressure passes downstream of the obturator - through the internal bypass - and balances it. After restoring the bushing **513**, it has to be press-fit into its seat.

The opening or closing status of the slam-shut valve is detectable from outside by observing the position of the colored cap **531** through the plug **532**.



3.2 CALIBRATION SPRINGS OF THE SLAM-SHUT DEVICE LA/...

Table 3.1 shows the tripping ranges available for the pressure switches.

FEATURES OF THE SPRINGS FOR LA/BP SLAM-SHUT DEVICE							
Pos.	Code	Color	d	Lo	De	N.	Calibration range (mbar)
							Tripping due to maximum pressure
1	64470112RO	RED	2,2	44	34		30 ÷ 49
2	64470115GR	GREY	2,8	42	34		50 ÷ 180
							Tripping due to minimum pressure
12	64470024BI	WHITE	1,3	45	15		6 ÷ 60
d = Ø wire Lo = Spring length De = Ø external N. = Spring Note							

FEATURES OF THE SPRINGS FOR LA/MP SLAM-SHUT DEVICE							
Pos.	Code	Color	d	Lo	De	N.	Calibration range (mbar)
							Tripping due to maximum pressure
3	64470115GR	GREY	2,8	42	34		140 ÷ 179
4	64470116GI	YELLOW	3,2	40	34		180 ÷ 279
5	64470051BI	WHITE	3,2	50	34		280 ÷ 450
							Tripping due to minimum pressure
13	64470024BI	WHITE	1,3	45	15		10 ÷ 59
14	64470038GI	YELLOW	2	40	15		60 ÷ 240
d = Ø wire Lo = Spring length De = Ø external N. = Spring Note							

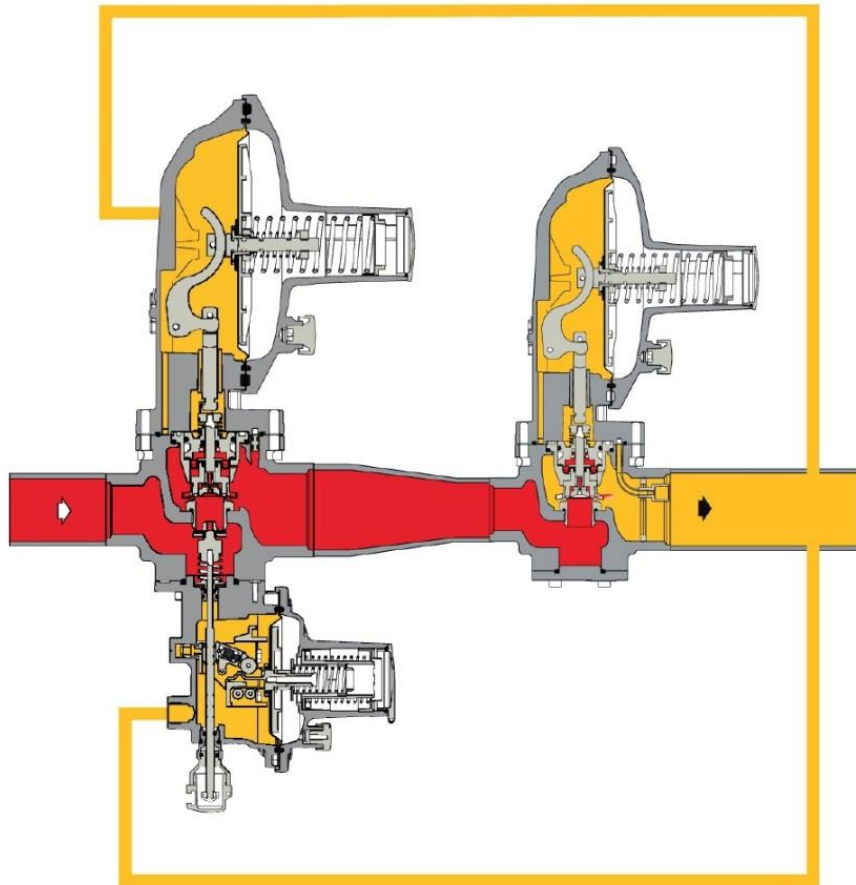
FEATURES OF THE SPRINGS FOR LA/TR SLAM-SHUT DEVICE							
Pos.	Code	Color	d	Lo	De	N.	Calibration range (mbar)
							Tripping due to maximum pressure
6	64470116GI	YELLOW	3,2	40	34		250 ÷ 549
7	64470051BI	WHITE	3,2	50	34		550 ÷ 849
8	64470057BL	BLUE	3,5	50	34		850 ÷ 1399
9	64470058AR	ORANGE	4	50	34		1400 ÷ 2499
10	64470059AZ	LIGHT BLUE	4,5	50	34		2500 ÷ 3999
11	64470060NE	BLACK	5	48	34		4000 ÷ 5500
							Tripping due to minimum pressure
15	64470038GI	YELLOW	2	40	15		100 ÷ 499
16	64470045MA	BROWN	2,4	41	15,3		500 ÷ 999
17	64470046BL	BLUE	3	40	15		1000 ÷ 1999
18	64470149NE	BLACK	3,2	43	15		2000 ÷ 3500
d = Ø filo (mm) Lo = Lunghezza Molla (mm) De = Ø esterno (mm) N. = Note Molla							

3.3 DIVAL 500 WITH MONITOR OPERATION

The monitor is an emergency regulator, having the task of taking over the service in the place of the main regulator when this latter, due to a failure of the same, allows the outlet pressure to reach the calibration value set for the monitor regulator. For this emergency device, PIETRO FIORENTINI has a solution for installations with an line monitor regulator.

3.3.1 FEATURES

DIVAL 500, with monitor function, is a regulator that, compared to the standard version, does not have any internal sensing line but the preparation only for external sensing line.



4.0 ACCESSORIES

4.1 RELIEF VALVE

The relief valve is a safety device that discharges to atmosphere a certain amount of gas when the pressure at the control point exceeds the set one due to short occurrences, such as the closing of the on-off valves in a very short time and/or an overheating of the gas with zero requested flow rate. The discharge of the gas to atmosphere can, for example, avoid the tripping of the slam-shut device for transient causes not resulting from damages to the regulator. Obviously, the amount of gas released depends on the extent of the overpressure with respect to the calibration pressure.

The different models of relief valves available are all based on the same operating principle, which is described below with reference to the valve **VS/AM 65** (fig. 10).

It is based on the comparison between the thrusts applied on the membrane **24** resulting from the pressure of the gas to be controlled and the thrust resulting from the calibration spring **20**. The weight of the moving equipment, the static thrusts and the residual dynamic ones acting on the obturator **4** are also considered in this comparison.

When the thrust resulting from the gas pressure exceeds that of the calibration spring, the obturator **4** is lifted with the subsequent discharge of a given quantity of gas. As soon as the pressure falls below the calibration value, the obturator returns to the closed position.

The control and adjustment of the relief valve tripping can be done by following the procedures described here below.

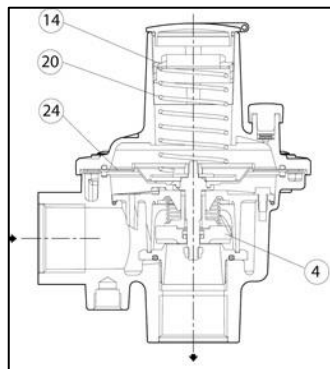


Figure 10: VS/AM 65

4.1.1 DIRECT INSTALLATION IN THE LINE (fig. 11).

When the relief valve is mounted directly on the line, i.e. without the interposition of an on-off valve, proceed as follows:

1. Make sure that the outlet on-off valve **V2** and the purge/vent valve **6** are closed;
2. Connect to the valve **6** a controlled auxiliary pressure and stabilize it at the desired value for the opening of the relief valve; open the valve **6** causing a consequent increase in the pressure in the outlet segment;
3. Verify the opening of the relief valve **15** and, if necessary, adjust it by appropriately turning the internal adjustment ring nut **14** (clockwise to increase the setting; counter-clockwise to decrease it).

4.1.2 INSTALLATION WITH ON-OFF VALVE (fig. 12)

1. Close the on-off valve **16**;
2. Connect to the connection point **17** a controlled auxiliary pressure and increase it slowly until reaching the expected value for the opening of the relief valve;
3. Verify the opening of the relief valve **15** and, if necessary, adjust it by appropriately turning the internal adjustment ring nut **14** (clockwise to increase the setting; counter-clockwise to decrease it).

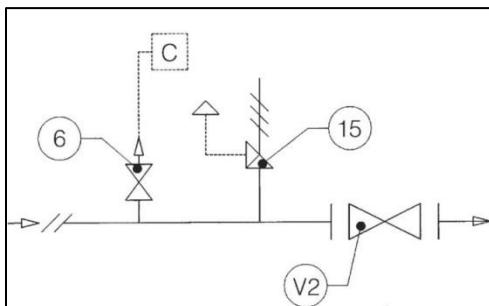


Figure 11: Direct connection to the line

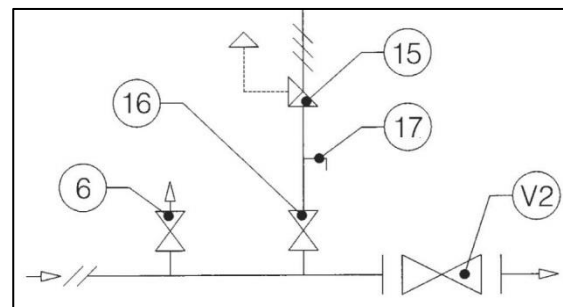


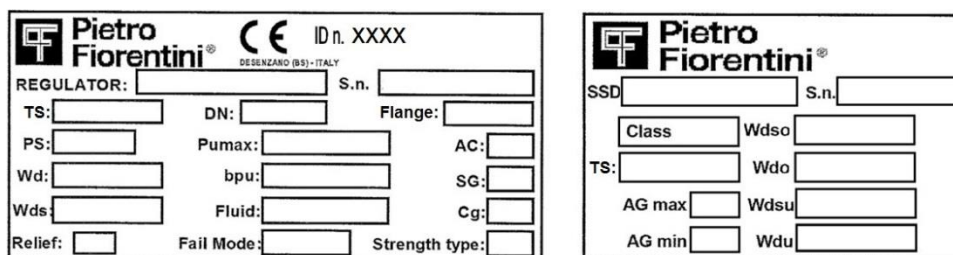
Figure 12: Connection with on-off valve

5.0 COMMISSIONING

5.1 GENERAL

After the installation, verify that the on-off valves at inlet and outlet, any available bypass, and the relief valve are closed. Before commissioning, it is recommended to verify that the expected operational conditions meet the features of the equipment. Such features are identified by the corresponding symbols on the rating plates present on the equipment itself (fig. 13). It is recommended to enable the opening and closing valves very slowly. Too fast maneuvers may damage the regulator. It shall be noted that the regulator with monitor function is identified with an additional plate (fig. 14).

EQUIPMENT RATING PLATES



REGULATOR		S.n.	
TS:	DN:	Flange:	
PS:	Pumax:	AC:	
Wd:	bpu:	SG:	
Wds:	Fluid:	Cg:	
Relief:	Fail Mode:	Strength type:	

SSD		S.n.	
Class	Wdso		
TS:	Wdo		
AG max	Wdsu		
AG min	Wdu		

Figure 13: Equipment rating plates

MONITOR

Figure 14: Additional rating plate

Here below there is the list of the symbols used together with their meaning.

CE = Compliance with Directive 97/23/EC (PED)

Pumax= maximum operation pressure at device inlet.

bpu= range of variability of the inlet pressure of the pressure regulator under normal operating conditions

PS= maximum allowable pressure that can be born under safety conditions by the device body structure.

Wds= calibration range of the pressure regulator/ pilot/ pre-reduction unit that can be obtained using the parts and the calibration spring installed upon final testing (i.e. not changing any components of the device).

Wd= calibration range of the pressure regulator/ pilot/ pre-reduction unit that can be obtained using the calibration springs indicated in the proper tables and also by changing some other parts of the device (reinforced pad, membranes, etc ...).

AC= regulation class

SG= class of the lockup pressure

AG = block tripping accuracy.

Wdo = overpressure tripping range of the slam-shut valve, which can be obtained by using the various calibration springs listed in the table.

Wdso = overpressure tripping range of the slam-shut valve, which can be obtained by using the various calibration spring mounted during final testing.

Wdu = underpressure tripping range of the slam-shut valve, which can be obtained by using the various calibration springs listed in the table.

Wdsu = underpressure tripping range of the slam-shut valve, which can be obtained by using the various calibration spring mounted during final testing.

5.2 GAS FEEDING, CHECK OF EXTERNAL TIGHTNESS AND CALIBRATIONS

Pressure feeding to the equipment shall be performed very slowly. When a speed-limiting procedure is not in place, it is recommended to keep the gas speed in the feeding piping under a value of 5 m/sec during the pressure feeding phase. In order to prevent the equipment from being damaged, the following shall be absolutely avoided:

- Pressurization through a valve positioned downstream of the equipment itself.
- Depressurization through a valve positioned at inlet of the equipment itself.

The external tightness is assured when by applying a foam medium on the element under pressure no bubbles are produced. The regulator and any other devices (slam-shut valve, monitor) are normally supplied already calibrated to the required value. Moreover, it may happen that due to several reasons (e.g. vibrations during transport) the calibrations may be subject to slight changes, though remaining within the range of the values allowed by the springs used. Therefore, it is advisable to verify the calibrations according to the procedures outlined here below. In installations consisting of two lines, it is recommended to commission one line at a time, starting from the one with the lower calibration value, i.e. the so-called "spare", "backup" or "standby" line.

Before commissioning the regulator, it is necessary to verify that all on-off valves (inlet, outlet, and bypass - if any) are closed and that the gas has such a temperature as not to create malfunctions.

5.3 COMMISSIONING THE REGULATOR

If on the line there is also a relief valve, refer to par. 4.1 to check it.

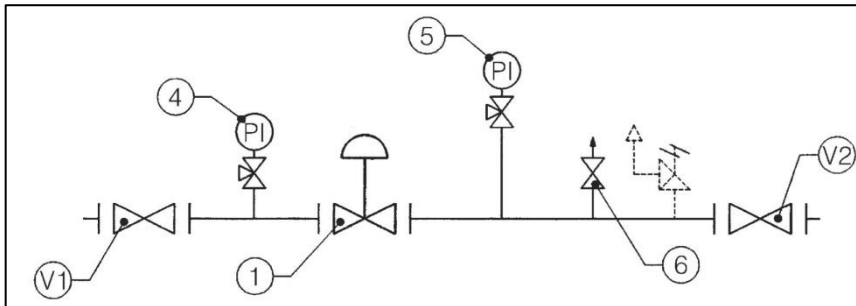


Figure 15: Dival diagram (internal sensing line)

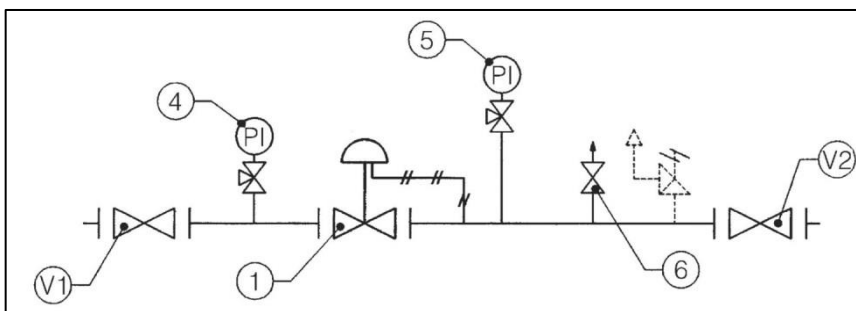


Figure 16: Dival diagram (internal and external sensing line)

1. Partially open the relief valve 6 located on the outlet piping;
2. Very slowly, open the inlet on-off valve V1;
3. Once the inlet and outlet pressure values have stabilized, using the pressure gauge 5, check that the outlet pressure shows the desired calibration value. Should this not be the case, adjust the calibration by acting on the proper internal ring nut (fig. 1), turning it clockwise to increase and counterclockwise to decrease the value;
4. Close the relief valve and check the tightness of the regulator and the value of its lockup overpressure;
5. With a foamy substance, check the tightness of all the joints present between the on-off valves V1 and V2;
6. Very slowly open the outlet on/off valve V2 until reaching the complete filling of the piping.

5.4 COMMISSIONING THE REGULATOR WITH EMBEDDED SLAM-SHUT VALVE LA/...

If on the line there is also a relief valve, refer to par. 4.1 to check it.

5.4.1 CHECKING THE SLAM-SHUT VALVE LA

Check and record the tripping of the lam-shut device **7** as follows:

- A. For the slam-shut devices with internal sensing line proceed as follows:

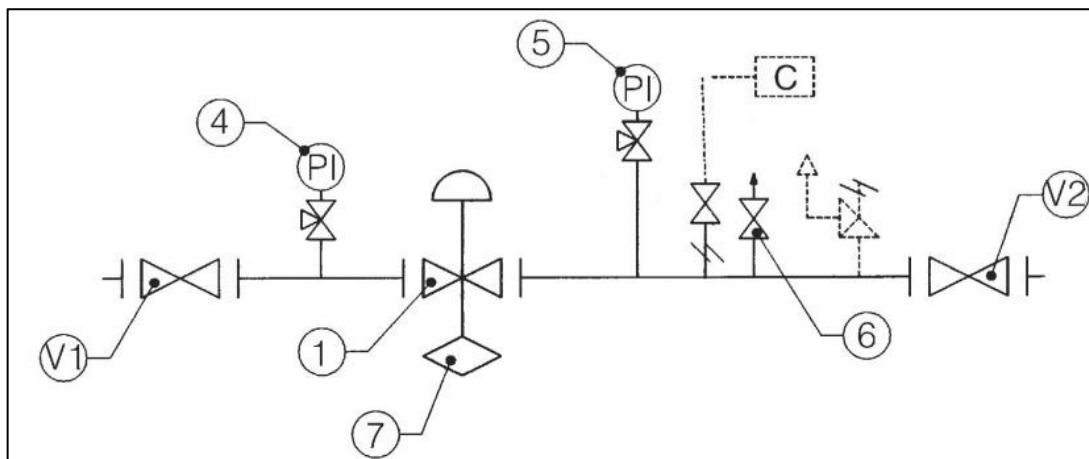
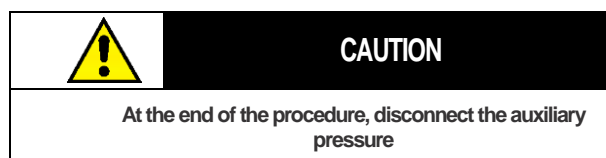


Figure 17: Dival diagram (internal sensing line) with embedded slam-shut valve (internal sensing line)

1. Connect a controlled auxiliary pressure C downstream;
2. Stabilize this pressure at the calibration value set for the regulator;
3. For safety devices that:
 - trip in case of maximum pressure: slowly increase the auxiliary pressure and verify the tripping value. If necessary, increase the tripping value by rotating clockwise the adjustment ring nut 549; rotate it counter-clockwise to decrease the tripping value.
 - trip in case of pressure increase and decrease, slowly increase the auxiliary pressure and record the tripping value. Restore the pressure to the calibration value of the regulator and perform the block restoration operation. Check the tripping due to pressure decrease by slowly reducing the auxiliary pressure. If necessary, increase the values for tripping in case of pressure increase or decrease by turning clockwise the ring nuts 549 or 548, respectively. Proceed inversely to decrease the tripping values.



Remark:

- If there is an external relief valve, bypass such device before checking the slam-shut device.
- If there is an internal relief valve, either bypass such device before checking the slam-shut device or connect a controlled auxiliary pressure with a flow rate greater than that of the relief device.

- B. For the slam-shut devices connected to the downstream piping through the "push" three-way switch valve 11, proceed as follows:

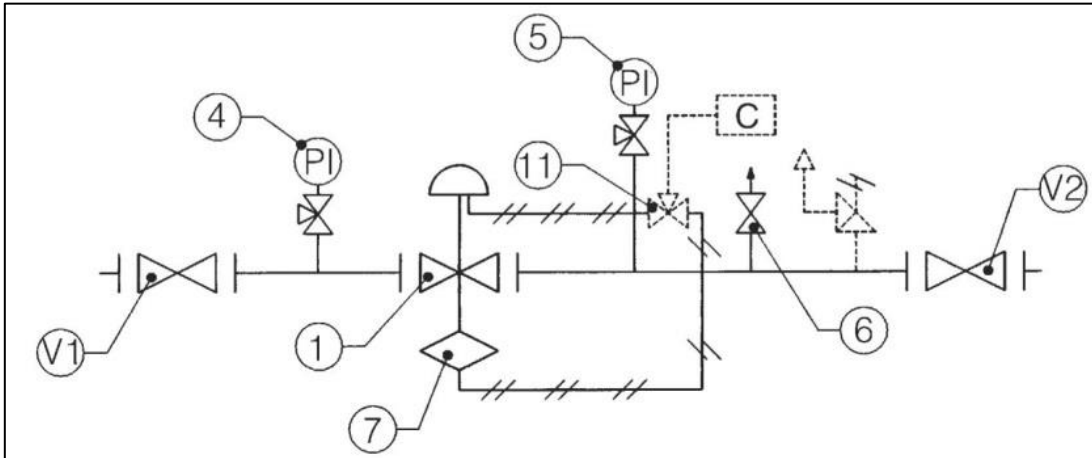


Figure 18 Dival diagram (internal and external sensing line) with embedded slam-shut valve (internal and external sensing line)

1. Connect a controlled auxiliary pressure C to the "push" valve;
2. Stabilize this pressure at the calibration value set for the regulator;
3. Completely press the knob 1 of the "push" three-way valve;
4. Restore the slam-shut device by means of the suitable bushing;
5. Keep the knob 1 pressed and:
 - For the safety devices tripping in case of maximum pressure: slowly increase the auxiliary pressure and verify the tripping value. If necessary, increase the tripping value by rotating clockwise the adjustment ring nut 549; rotate it counterclockwise to decrease the tripping value.
 - For the safety devices tripping in case of pressure increase and decrease: slowly increase the auxiliary pressure and record the tripping value. Restore the pressure to the calibration value of the regulator and perform the block restoration operation. Check the tripping due to pressure decrease by slowly reducing the auxiliary pressure. If necessary, increase the values for tripping in case of pressure increase or decrease by turning clockwise the ring nuts 549 or 548, respectively. Proceed inversely to decrease the tripping values.

Make sure that the operation is correct by repeating the procedure for at least 2-3 times

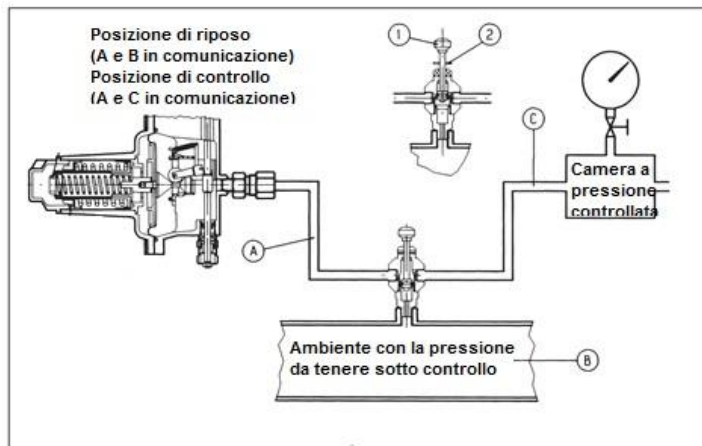


Figure 19: "Push" connection diagram

- C. For devices not equipped with "push" valve, it is recommended to separately connect the control head to a controlled auxiliary pressure and repeat the operations described above.

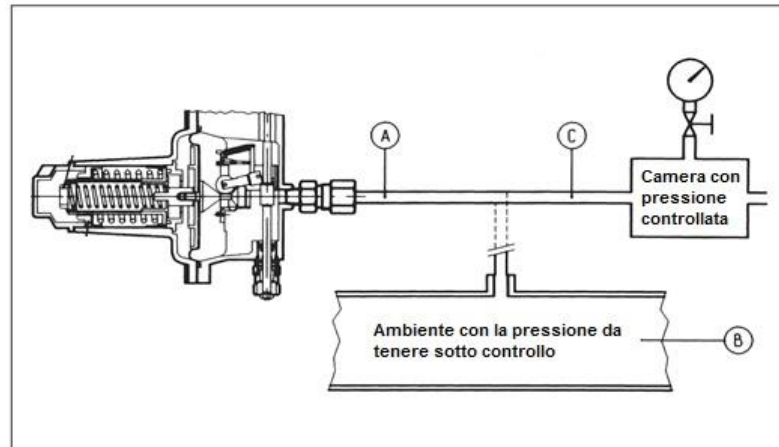
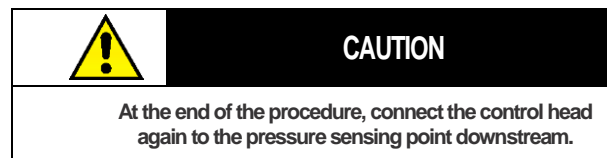


Figure 20



NB.: It is recommended to repeat the tripping tests at least every **6 months**.

At the end of the slam-shut device check operations, proceed as follows:

- Make sure that the slam-shut device is in closed position;
- Open the inlet on-off valve V1;
- Very slowly open the slam-shut valve, by pulling the proper bushing;
- Partially open the relief valve 6 on the outlet piping;
- Using the pressure gauge 5, check that the downstream pressure has the wished calibration value for the regulator. Should this not be the case, adjust the calibration by acting on the internal ring nut, turning it clockwise to increase and counterclockwise to decrease the value;
- Close the relief valve 6 and check the lockup pressure value;
- With a foamy substance, check the tightness of all the joints present between the on-off valves V1 and V2;
- Very slowly open the outlet on-off valve V2 until reaching the complete filling of the piping;

5.5 COMMISSIONING THE REGULATOR PLUS IN-LINE MONITOR DIVAL 500 WITH EMBEDDED SLAM-SHUT VALVE LA/...

If on the line there is a relief valve, refer to par. 4.1 to check it.

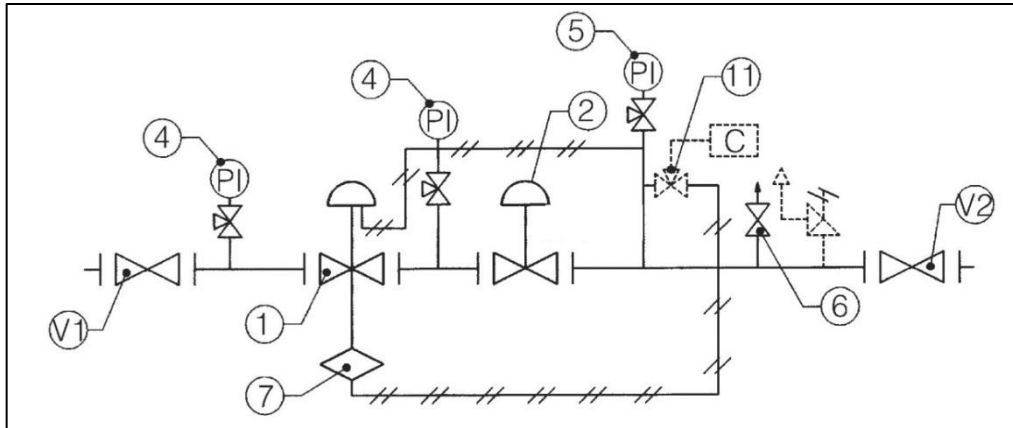


Figure 21: Monitor + Active Regulator Diagram (internal sensing line)

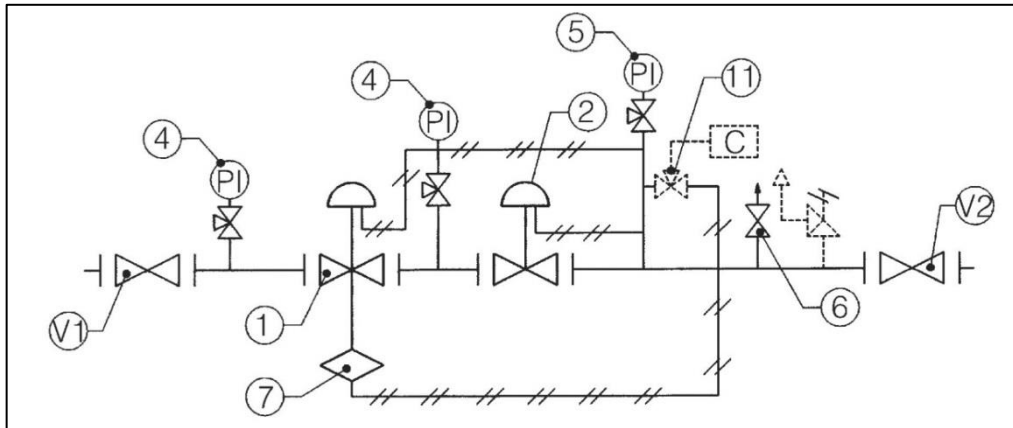


Figure 22: Monitor + Active Regulator Diagram (internal and external sensing line)

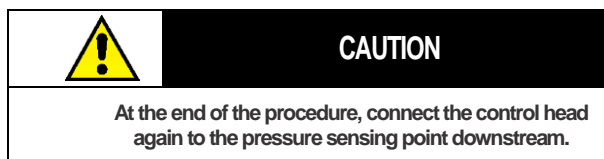
Check and record the tripping of the slam-shut device 7 as follows:

- A) For the slam-shut devices connected to the downstream piping through the "push" three-way switch valve 11, proceed as follows (fig. 19):
1. Connect a controlled auxiliary pressure C to the "push" valve;
 2. Stabilize this pressure at the calibration value set for the regulator;
 3. Completely press the knob 1 of the "push" three-way valve;
 4. Restore the slam-shut device by means of the suitable bushing;
 5. Keep the knob 1 pressed and:
 - For the safety devices tripping in case of maximum pressure: slowly increase the auxiliary pressure and verify the tripping value. If necessary, increase the tripping value by rotating clockwise the adjustment ring nut 549; rotate it counter-clockwise to decrease the tripping value.
 - For the safety devices tripping in case of pressure increase and decrease: slowly increase the auxiliary pressure and record the tripping value. Restore the pressure to the calibration value of the regulator and perform the block restoration operation. Check the tripping due to pressure decrease by slowly reducing the auxiliary pressure. If necessary, increase the values for tripping in case of pressure increase or decrease by turning clockwise the ring nuts 549 or 548, respectively. Proceed inversely to decrease the tripping values.

Make sure that the operation is correct by repeating the procedure for at least 2-3 times



- B) For devices not equipped with "push" valve (fig. 20), it is recommended to separately connect the control head to a controlled auxiliary pressure and repeat the operations described above.



NB.: It is recommended to repeat the tripping tests at least every **6 months**.

At the end of the slam-shut device check operations, proceed as follows:

- Make sure that the slam-shut device is in closed position;
- Partially open the relief valve 6 located on the outlet piping;
- Very slowly, open the on-off valve V1;
- Very slowly open the slam-shut valve, by pulling the proper bushing;
- Increase the calibrations of the main regulator 2 until the monitor regulator 1 trips, acting on the proper internal ring nut, turning it clockwise;
- Using the pressure gauge 4 and 5, check that the outlet pressure shows the calibration value preset for the monitor regulator 1. Should this not be the case, adjust the calibration by acting on the proper internal ring nut, turning it clockwise to increase and counterclockwise to decrease;
- Close the relief valve and check the lockup pressure value of the monitor regulator 1;
- Let the slam-shut valve trip and partially open the relief valve 6;
- Very slowly open the slam-shut valve, by pulling the proper bushing;
- Decrease the calibrations of the main regulator 2 until bypassing the monitor regulator 1, acting on the proper ring nut, turning it counterclockwise;
- Set the calibration of the main regulator 2 to the set calibration values; then, using the pressure gauge 5, check the calibration values;
- Close the relief valve and check the lockup pressure value of the main regulator 2;
- With a foamy substance, check the tightness of all the joints present between the on-off valves V1 and V2;
- Very slowly open the outlet on-off valve V2 until reaching the complete filling of the piping;



6.0 TROUBLESHOOTING

Some of the operational anomalies that may occur from time to time, are described below. These are phenomena linked to the gas conditions, as well as, of course, to the natural aging and wear of the materials.

Please note that all interventions on the equipment **must be performed by technically qualified personnel having suitable knowledge on the matter.**

The tampering and improper use of the equipment by non-qualified personnel relieves Pietro Fiorentini SpA from any liability whatsoever.

6.1 ANOMALIES OF THE REGULATOR DIVAL 500

Table 6.1 describes the possible anomalies that the regulator may show.

INCONVENIENCE	POSSIBLE CAUSES	INTERVENTION
Lack of tightness at Q=0	Valve seat [102] damaged	Replacement
	Obturator [211] damaged	Replacement
	O-rings damaged	Replacement
	Membrane [322] damaged	Replacement
	Dirt or foreign bodies in the sealing area	Cleaning
Pumping	Abnormal frictions in the stem-obturator assembly [305]	Cleaning and replacement, if necessary, of the sealing and/or guide elements
	Reduced volumes downstream	Increase in the volume
Increase of Pd with Q>0	Breakage of the membrane [322]	Replacement

6.2 ANOMALIES OF THE SLAM-SHUT DEVICE LA/...

Table 6.2 describes the possible anomalies that the slam-shut device may show.

INCONVENIENCE	POSSIBLE CAUSES	INTERVENTION
The blocking obturator does not close	Breakage of the membrane [536] of the measuring head	Replacement
Leak from the slam-shut valve obturator	Obturator gasket [526] deteriorated	Replacement
	Obturator seat eroded or scratched	Replacement
Wrong release pressure	Wrong calibration of the min. and/or max. spring	Perform the calibration again by acting on the ring nuts [549] and/or [549]
	Lever mechanisms subject to friction	Change the box containing the entire assembly
It is not possible to perform restoration	The cause, which led to the pressure increase or decrease downstream, persists	Let downstream pressure drop or increase it
	Broken or splintered lever mechanisms	Change the standard box containing the assembly outside the regulator

NB. If the slam-shut valve tripped, first of all close the inlet and outlet valves (V1 and V2) of the line and discharge the pressure. Solve the causes, which led to the tripping before restoring the equipment.

In case of malfunctions, if there is no qualified personnel available for the specific intervention, contact our customer service center nearest to you. For any further information, refer to our SATRI service at our plant in Arcugnano (VI), Italy.



7.0 MAINTENANCE

7.1 GENERAL

Maintenance, inspection and operation activities have to be carried out in compliance with the regulations in force on the matter in the place of installation of the equipment (type and frequency). Before performing any kind of intervention, it is important to ensure that the embedded slam-shut valve (if fitted) has been closed, that the inlet & outlet isolating valves have been closed and that all of the pressure has been discharged from the piping between the slam-shut valve and those isolating valves.

Maintenance interventions are strictly bound to the quality of the conveyed gas (impurities, humidity, gasoline, corrosive substances) and to the filtration efficiency.

Therefore, it is always recommended to perform preventive maintenance interventions whose frequency shall be determined according to the following aspects, unless specified by regulations already in force:

- The quality of the conveyed gas;
- The status of cleaning and preservation of the piping upstream of the regulator: as a rule, for example, after the first start of the plants, more frequent maintenance interventions are required due to the uncertain internal cleaning status of the piping;
- The reliability level required by the reduction plant.

Before starting disassembling the equipment, make sure:

- To have a series of original spare parts available. Spare parts shall be original spare parts by Pietro Fiorentini bearing in mind that the most important parts such as membranes are marked.
- To have a set of tools as shown in table 7.5.

For proper maintenance, the recommended spare parts are unequivocally identified by tags indicating:

- The SS layout drawing number of the equipment in which they can be used;
- The position given on the SS layout drawing of the equipment; it is suggested to replace all rubber parts; for this purpose, use the suitable spare part kit available on Pietro Fiorentini website.

NB. The use of non-original parts relieves Pietro Fiorentini S.p.A. from any responsibility.

The depressurization procedure shall occur paying attention to discharge the drains in a safe area; to avoid risks related to the formation of sparks due to bumps of impurity particles inside the discharge lines, it is recommended to keep fluid speed lower than 5 m/sec.

Moreover, it is suggested to perform reference marks on the parts before disassembling those parts that can be positioned or oriented in more than one way during re-assembly.

Finally, it shall be underlined that the O-rings and the sliding mechanical parts (stems, etc.) have to be lubricated before reassembling them applying a thin layer of silicone grease. Before commissioning, it is necessary to verify the external tightness of the equipment at a suitable pressure for assuring the absence of external leaks.

The internal tightness of the slam-shut devices and of the monitors, when they are used as safety accessories according to the PED Directive, must be checked at a suitable pressure able to assure the internal tightness at the maximum working pressure expected.

These checks are essential in order to assure the safe use at the intended operating conditions; they shall, in any case, comply with the national regulations in force.

7.2 MAINTENANCE PROCEDURE FOR THE REGULATOR DIVAL 500

Procedure for disassembling, completely replacing the spare parts and re-assembling the pressure regulator.
DIVAL 500 + LA

PRELIMINARY OPERATIONS

1. Bring the regulator to its safety status.
2. Make sure that the pressure upstream and downstream of the same is zero.

DISASSEMBLING AND RE-ASSEMBLING

7.3 REGULATOR DIVAL 500

3. Disconnect the fittings between the regulator and the downstream pressure connection (sensing line), if any;
4. Unscrew the plug and the internal adjustment ring nut completely. Then remove the spring;



5. Remove the screws fastening the cover of the lower support and the upper one to one another;



6. Remove the upper cover;



7. Unscrew the nut completely and extract the spring;



8. Remove the membrane assembly;

9. Unscrew the nut to remove the protection disc, the membrane and the membrane support;



10. By raising and lowering them, check the proper functioning of the internal lever mechanisms;



CAUTION:

- INTERNAL RELIEF ACTIVE: the O-ring must be in the lower groove of the membrane shaft, fig. 3.
- INTERNAL RELIEF DISABLED: the O-rings must be in the three grooves, fig. 2

11. Remove the screws from the control head body;



12. Separate the head, together with the balancing assembly, from the body of the regulator;



13. Separate the balancing assembly from the head by performing a shift in the gas flow direction so that the stem comes out from the towing coupling;



14. Unscrew the screw from the obturator, unscrew the stem from the disc, and separate all components of the balancing assembly;



15. Unscrew the valve seat from the body, paying utmost care not to damage the sealing edges;



To re-assemble the regulator follow the procedure described for disassembly in reverse order.

Before reassembling the tightness elements (O-rings, membranes, etc.), it is necessary to check their integrity and, if necessary, replace them. Moreover, it is recommended to make sure that the membrane is fully inserted in its seat and that the movement of the stem-obturator assembly is not subject to any hindrance.

Once again, pay utmost care while handling the valve seat, in order not to damage the sealing edges. The internal adjustment ring nut must be only partially screwed.

The maintenance exclusively of the regulation valve (balancing assembly and valve seat) can be performed without intervening on the control head.

In this case, the operations to be carried out start from position 9, after performing step 1.

7.4 SLAM-SHUT VALVE LA/...

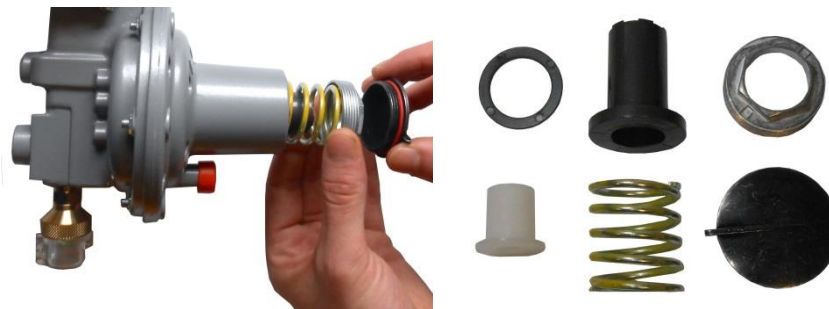
1. Make sure that the slam-shut device is in closed position;
2. Disconnect the fittings between the slam-shut valve and the downstream pressure sensing line;
3. Remove the screws that secure the slam-shut device to the body;



4. Remove the slam-shut device



5. Unscrew the plug and the adjustment ring nuts. Then remove the calibration springs and the spring supports;



6. Remove the body cover springs



7. Extract the membrane assembly from the body



8. Remove the plug, unscrew the nut and ring nut



9. Extract the shaft assembly from the top










10. Unscrew the nut and remove the obturator



To re-assemble the slam-shut valve, follow the procedure described for disassembly in reverse order. Before reassembling the tightness elements (O-rings, membranes, etc.), it is necessary to check their integrity and, if necessary, replace them.

7.5 WRENCHES FOR THE MAINTENANCE OF PRESSURE REGULATORS DIVAL 500 (+LA...)

Type	Tool	Description	
A		<ul style="list-style-type: none"> Combination spanner wrench 	Ch. 8-9-10-11-12-13-14-15-16-17-18-19-20-21-22-23-24-25-26-27-41
B		<ul style="list-style-type: none"> Adjustable spanner 	L. 30
C		<ul style="list-style-type: none"> Double polygonal box spanner 	Ch. 8-9-10-11-12-13-14-15-16-17-18-19-20-24-26-27-36-46
D		<ul style="list-style-type: none"> Hexagon Allen Wrench 	Ch. 3-4-5-6-7-8-19
E		<ul style="list-style-type: none"> Philips screwdriver 	Es.Ch PH 0 x 100 - PH 1x125 PH 2x150
F		<ul style="list-style-type: none"> Flat blade screwdriver 	0,5x3x75 1,2x6,5x125
G		<ul style="list-style-type: none"> Pliers for circlip rings 	Cod.10÷25 19÷60
			Tab. 7.5

8.0 FINAL OPERATIONS

8.1 TIGHTNESS AND CALIBRATIONS CHECK

- Open very slowly the on-off valve positioned at the inlet of the regulator and, using a foamy solution or the alike, check the following:
 - tightness of the regulator external surfaces;
 - tightness of the slam-shut valve;
 - tightness of the regulator internal surfaces;
- Operating very slowly, pull the bushing of the slam-shut valve until opening only the internal bypass. Then when pressure has equalized, pull until the coupling is latched position;
- Check the tightness of the reinforced gasket of the regulator;
- At regulator outlet, open a vent valve able to create a small gas flow rate;
- Screw the internal adjustment ring nut until reaching the desired calibration value;
- Close the vent valve venting to the atmosphere;

8.2 COMMISSIONING

- Very slowly open the outlet on-off valve and if necessary, adjust the ring nut, to ensure the correct outlet pressure if the regulator.
- Tighten the plug



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