

System description

**T-Mon  
Spraying  
System**



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## 1. INTRODUCTION

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The spraying lubrication is used where lubricating greases, lubricating oils or even adhesive lubricants need to be applied in an even, metered and selective manner due to user-specific and function-related requirements.

The spraying lubrication allows reductions of up to 50% in the quantities consumed, which is significantly beneficial in terms of the disposal of lubricant and the associated costs. In particular this lubrication system is used in the area of heavy-duty gearing (e.g. drives for rotary kilns, cement mills, coal mills, mixing drums etc.).

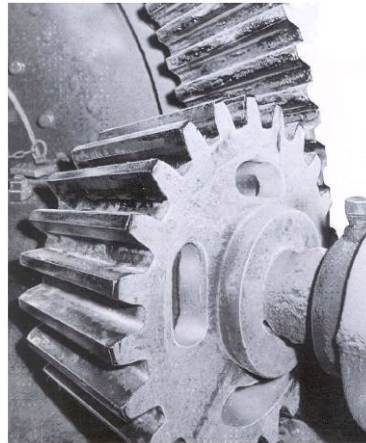


Fig. 1: Heavy-duty gearing in a cement mill

Experience has shown that the motive force is not yet transmitted by the full tooth face during the commissioning of these drives. The teeth profiles need a certain running-in time to adapt to each other. This running-in period can be extremely long however on account of the necessary material characteristics in the drive components. The resulting constant unilateral load can lead to premature damage etc. To counteract this, the development of adhesive lubricants was begun 30 years ago.

Whereas these graphitic and black coloured lubricants contained lead additives, chlorine and to some degree CFC as solvents at the beginning, these additives were eliminated over the course of time. Today, newly-developed transparent semi-synthetic or fully synthetic lubricants are available on the market which contain a different kind of additives without graphite. These lubricants are characterised by high to very high viscosities and have the advantage that they can be classified under class IV under TA-Luft (German Clean Air Act), which in turn has the effect of reducing disposal costs.

The positive lubrication characteristics of modern very viscous lubricants contrast however with the unfavourable delivery and spraying behaviour in central lubrication systems. In particular at low temperatures, to which the systems are frequently exposed, the spraying of the special lubricants without appropriate heating is possible but inadequate. Precisely for these applications this spray nozzle was developed on the basis of many years of experience to offer the option of heating and also the possibility of monitoring the passage of air and lubricant.

This means that the user can select the ideal lubricant to take account of the operating and ambient conditions as well as the specifications set by the drive manufacturers. The spraying lubrication system allows the use of almost all standard special lubricants.



## 2. PURPOSE OF THE SPRAYING LUBRICATION SYSTEM

With the spraying lubrication systems the lubricant is applied selectively and in metered quantities onto surfaces (e.g. teeth flanks) in order to ensure reliable lubrication.

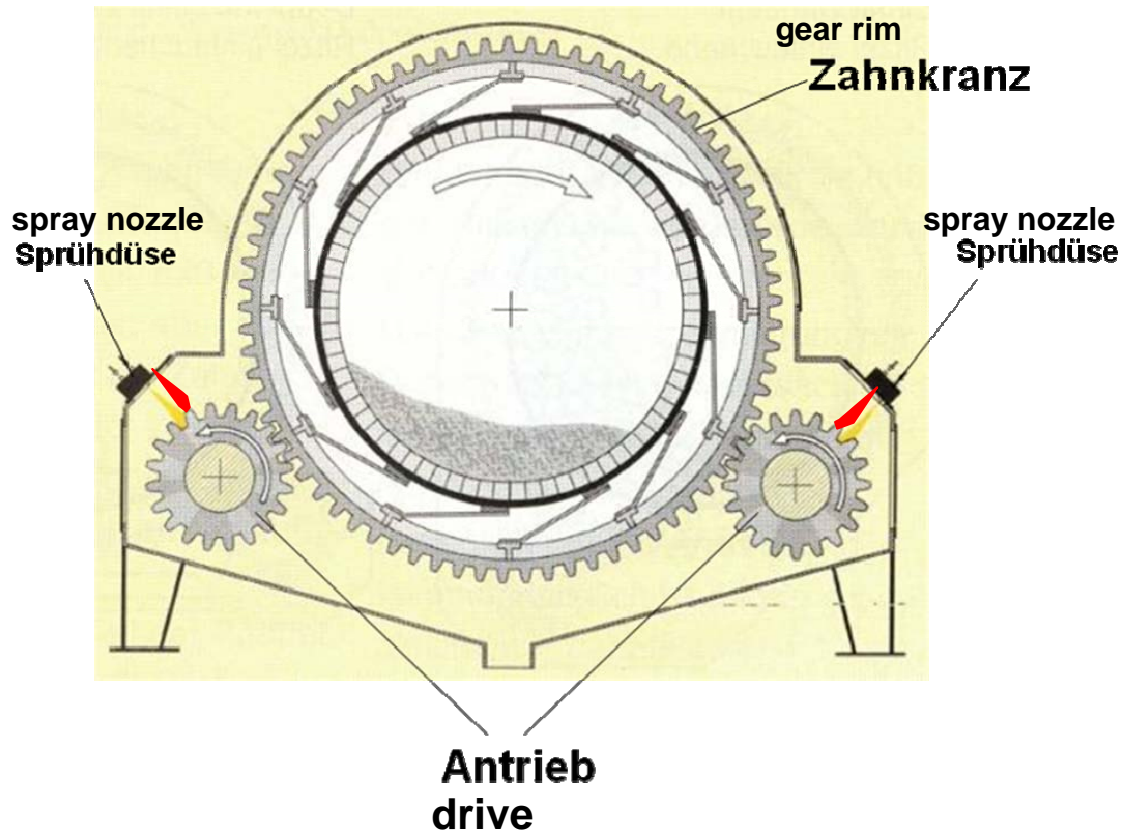


Fig. 2: cross-section through a cement mill with 2 drive pinions

The frequency of lubrication is based on defined intervals in most cases, in particular alternating intervals during the running-in phase and continuous operation phases, for heavy-duty gearing. The mechanical construction of the spraying lubrication system and the freely programmable electrical control satisfy these requirements. We refer to these as "pulse lubrication systems".

The continuous spraying-on of a quantity of lubricant suited to the operating conditions would be ideal in particular for heavy-duty gearing drives. However, this is not possible because of the mechanical sequence in the spraying lubrication systems. Furthermore, the constantly flowing compressed air, which distributes the lubricant through spray nozzles onto the teeth flanks, considerably increases operating costs.

Accordingly pulse lubrication systems have proved successful for years without the need to consider any compromise.



### 3. CONSTRUCTION OF THE SPRAYING LUBRICATION SYSTEM

Under normal conditions a spraying lubrication system consists of the following main components:

- pump\*
- compressed air preparation unit for pump and/or spray nozzles
- single nozzles or spraying station
- electrical switchgear

The main components are described in more detail in the following:

#### 3.1 Pumps

As feed pumps electrical pumps with tank (a) or pneumatically (b)/electrically (c) driven barrel pumps can be used, whereby the advantage of the barrel pumps is that they can deliver directly from standard commercial containers.

a) FZ-B pump



b) FP-S pump



c) BF-E pump



Fig. 1: Pumps for spraying lubrication systems

The selection of the pump depends primarily on the system size. If a system consists of a few single nozzles, the **FZ-B** pump is recommendable as an inexpensive solution because the tank capacity of 8 or a max. 30 litres is sufficient.

Barrel pumps make sense in particular in installations with heavy-duty gearing and accordingly a higher number of nozzles or spraying plates. As spraying systems have to have a compressed air connection anyway, the **FP-S** pneumatic barrel pump is used in most cases. The advantages of this pump are the direct delivery from commercial containers as well as the fact that they empty almost completely, which makes them much easier to handle and minimises the danger of contaminating the lubricant.

#### 3.2 DLS compressed air station

The compressed air is provided by the spraying lubrication system operator or by means of a compressor selected on the basis of the operational requirements and ambient conditions. If the compressed air supply is provided by the operator, it must be ensured that dried compressed air is provided at ambient temperatures under +5°C. Otherwise icing can occur on the nozzle tip and in the air motor in pneumatically driven barrel pumps.



### 3. CONSTRUCTION OF THE SPRAYING LUBRICATION SYSTEM (continuation)

#### 3.2.1 DLS compressed air station for systems with pneumatically driven barrel pump:

For this application a separate compressed air preparation is necessary for pump and spray nozzles/spraying stations combined on a standard compressed air station.

##### Construction:

Separate compressed air preparation and control for

- spraying station (filter regulator 1/2") and
- barrel pumps (filter regulator 1/4", 3/2-way solenoid valve DC 24V, throttle) as well as a
- connection for the lubricant line with manometers

in one unit.

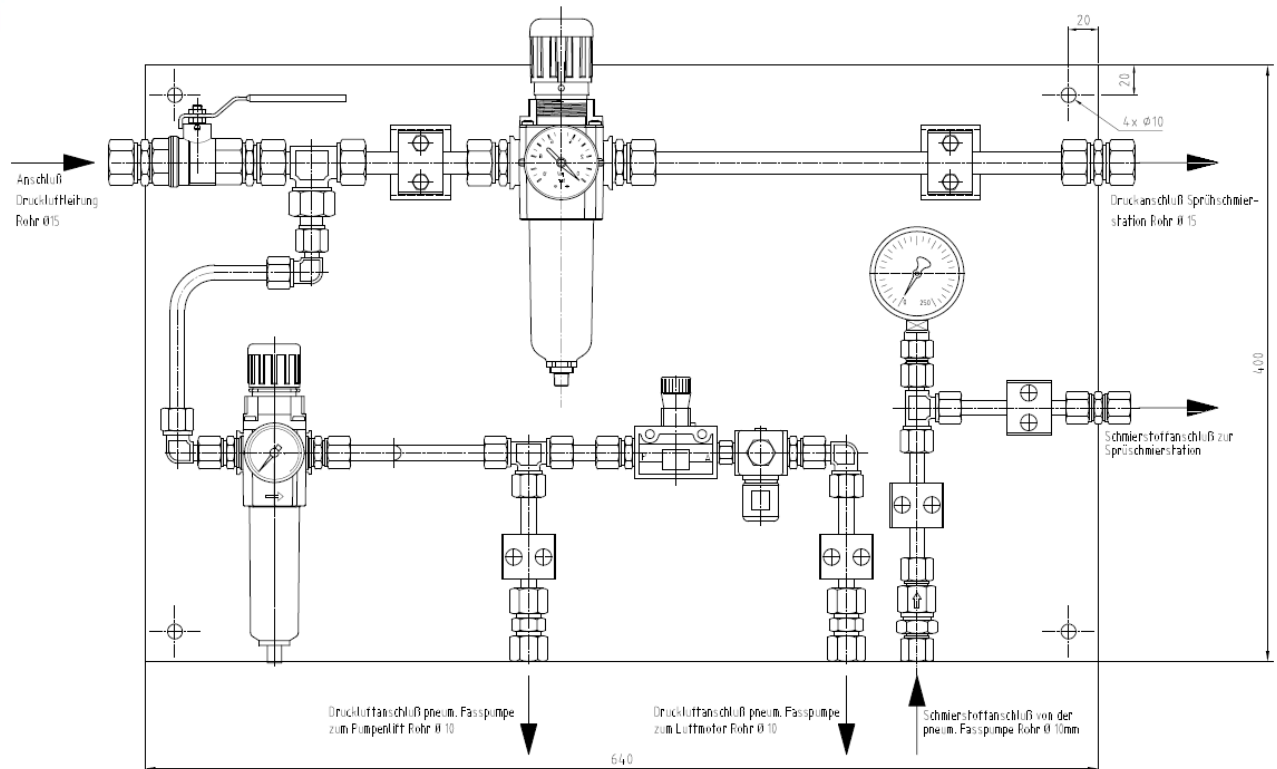


Fig. 4: Example of a standard DLS compressed air station for systems with a pneumatic barrel pump and spray nozzles

### 3. CONSTRUCTION OF THE SPRAYING LUBRICATION SYSTEM (continuation)

#### 3.2.2 DLS compressed air station for systems with electrically driven feed pump and spray nozzles on a spraying station:

Systems with electrically operated pumps need only one compressed air preparation unit for the spraying station(s). Here one compact compressed air control unit consists essentially of:

- ball valve ½"
- filter regulator ½"

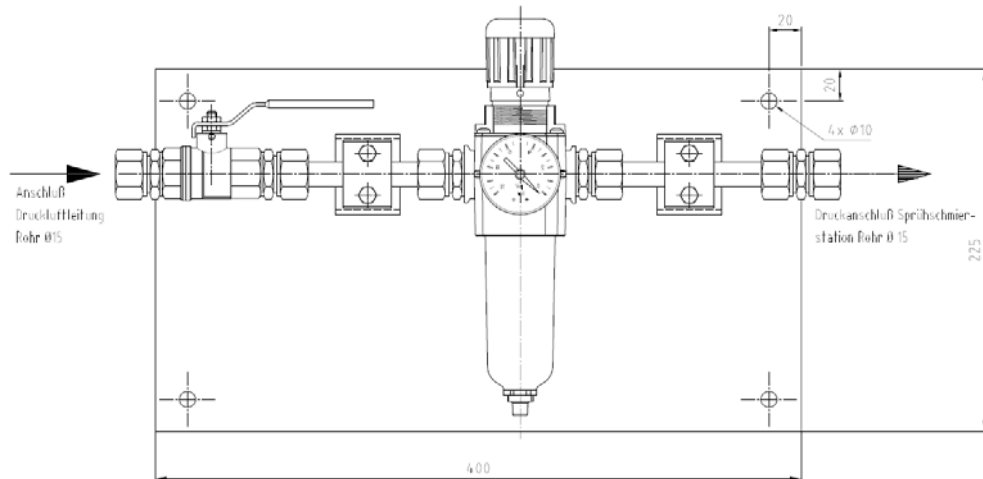


Fig. 5: Example of a standard DLS compressed air station for systems with electrical feed pumps

#### 3.2.3 Pressure control unit for systems with electrically driven feed pump and single nozzles:

Systems with electrically operated pumps and single nozzles also require a solenoid valve and pressure switch on the compressed air station. These components are integrated in the spraying station in 3.2.1 and 3.2.2. The main components therefore are:

- ball valve ½"
- filter regulator ½"
- 2/2-way solenoid valve 24V
- pressure switch

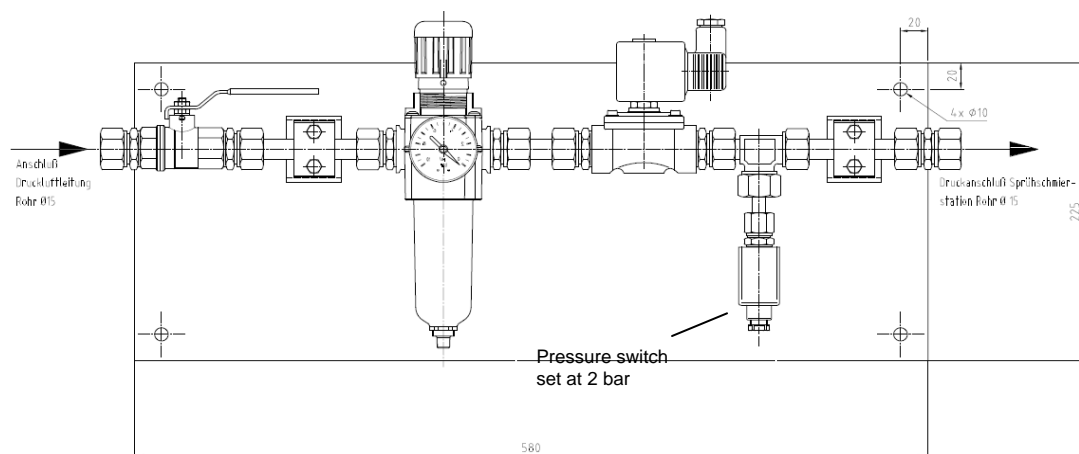


Fig. 6: Example of a standard DLS compressed air station for electrical feed pumps and single nozzles

### 3. CONSTRUCTION OF THE SPRAYING LUBRICATION SYSTEMS (continuation)

#### 3.3 SDU spray nozzle

The newly developed **SDU** spray nozzle is characterised by its compact and robust construction. With optional extensions it can be ideally adapted to the ambient conditions and specifications set by the systems operator.

##### 3.3.1 Variants of the SDU spray nozzle as a single nozzle

The following variants are possible:

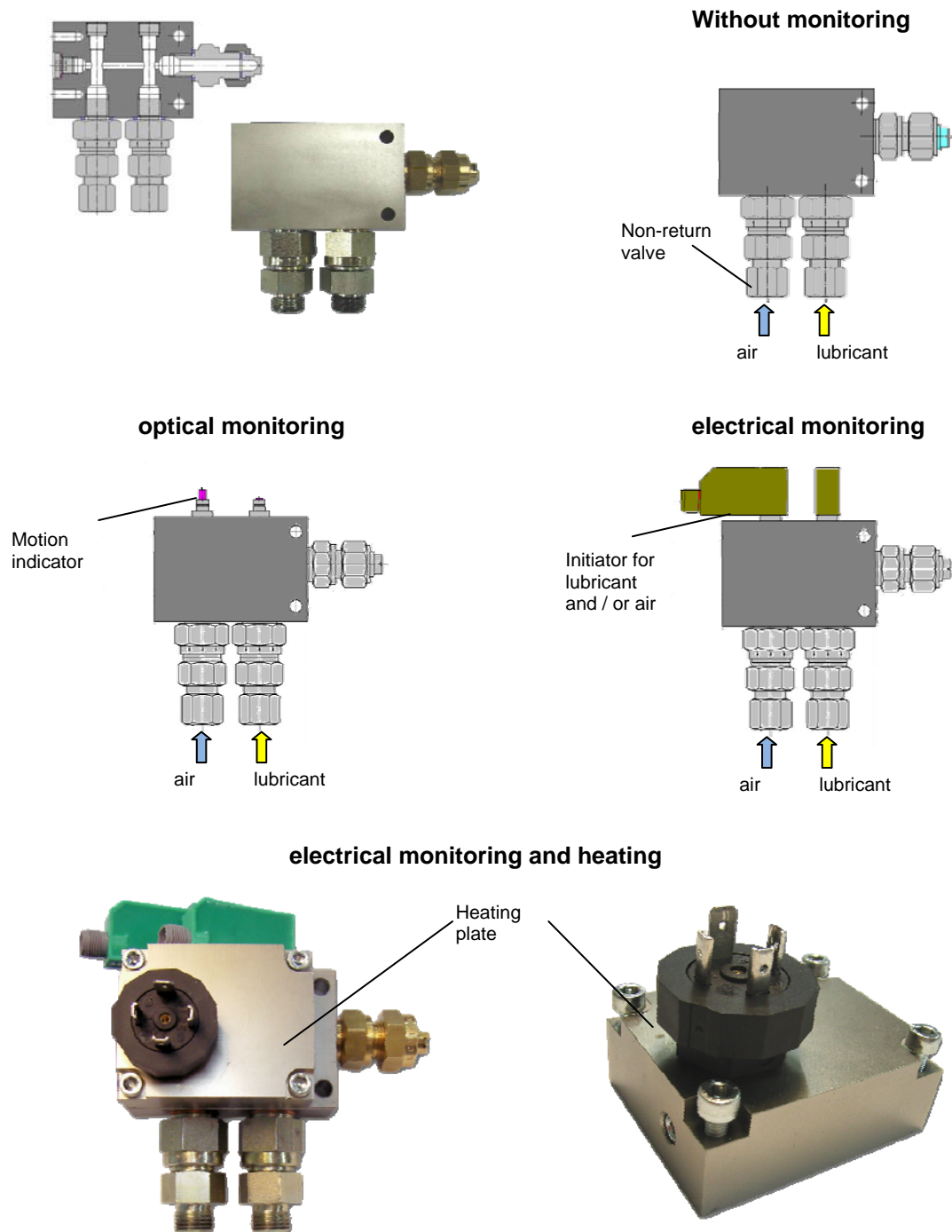


Fig. 7: Variants and development stages of the **SDU** spray nozzle





### 3. CONSTRUCTION OF THE SPRAYING LUBRICATION SYSTEM (continuation)

#### 3.3.2 SDU spray nozzle (on SPU spraying lubrication station)

For lubricating large surfaces, e.g. on heavy-duty gearing with standard pinion widths of 300 - 700 mm it is advisable to use finished spraying stations on which the nozzles are mounted already at the right spacing with all accessories. The stations are designed specially for the maintenance openings in the heavy-duty gearing and available for all standard pinion widths (in 50-mm increments). The spraying distance between the tip of the nozzle and the drive pinion is between 150 and 200 mm depending on the pinion width.

#### Construction:

- 2 to 6 spray nozzles, depending on the pinion width
- **ZP-A/G** progressive group lubrication distributor - the distributor inlet is connected here to the feed pump and the number of the outlets corresponds to the number of nozzles there.
- pressure switch for compressed air,
- solenoid valve in the lubricant and air supply
- monitoring switch for the distributor circulations
- inspection flap

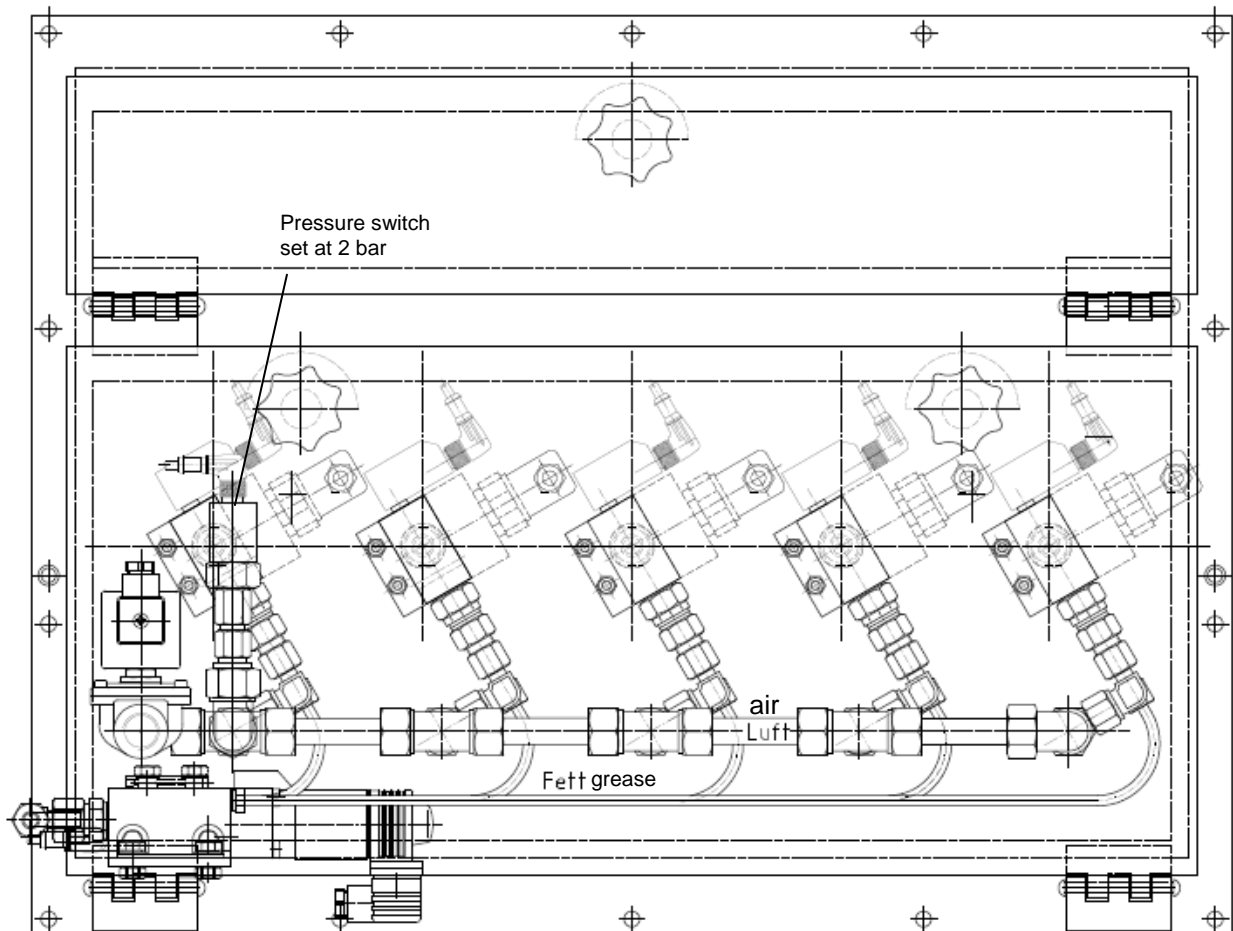


Fig. 8: Example of a standard SPU spraying station



### 3. CONSTRUCTION OF THE SPRAYING LUBRICATION SYSTEM (continuation)

#### 3.4 Electrical switchgear

The electrical switchgear regulates the interval lubrication and if appropriate serves as an interface to superordinated controls that coordinate the entire system. As standard it is constructed with the latest version of the Siemens LOGO! control module, whose externally visible display and control panel make operation comfortable for the user.

If the nozzles are not monitored, the LOGO! control is suitable for all system sizes. If monitored nozzles are used, the LOGO! control is necessary up to the 6<sup>th</sup> nozzle and as of the 7<sup>th</sup> nozzle a Siemens S7-200 control is required and supplied as standard.

The electrical switchgear is set up in a sheet-steel housing with IP54 degree of protection. (Fig. 9).

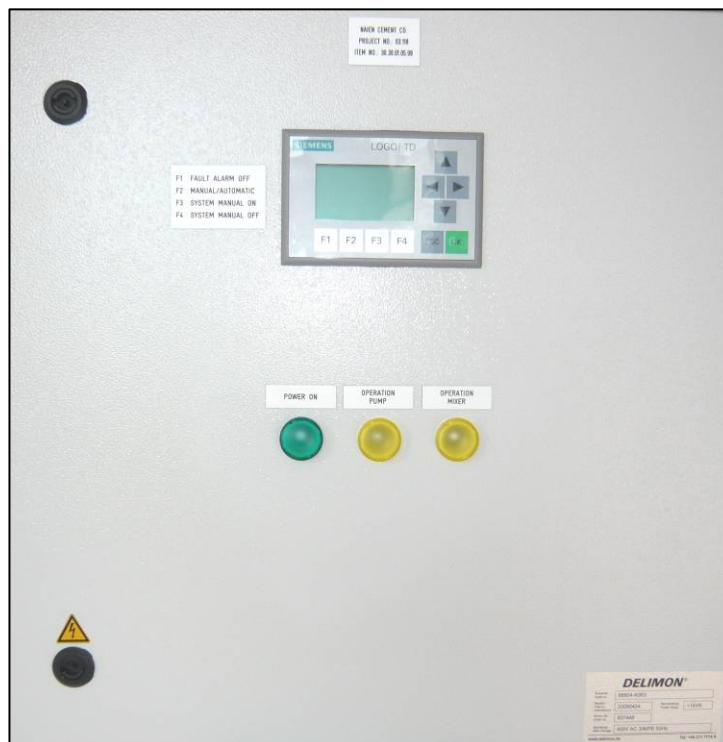


Fig. 9: Standard compact cabinet for electrical switchgear



#### 4. REQUIREMENTS SET FOR THE SPRAYING LUBRICATION SYSTEMS

- Being faced with harsh operating conditions, the components in the lubrication systems must be **robust and able to withstand mechanical stress** themselves. The dust coming from the surroundings may not affect their correct functioning.
- The lubrication systems must be **easy to assemble**. For this purpose, the components described under point 3 are supplied pre-assembled as ready-to-connect modules.
- The lubrication systems must be **maintenance-friendly** in order to facilitate as quick a replacement as possible in the event of a failure of an individual device. Consideration must also be given in the design phase to the operating conditions and maintenance work by non-qualified personnel and overall system downtime in production is reduced to a minimum.
- The individual devices in the lubrication systems must contain as low a content of mechanically movable parts as possible in order to **avoid wear on the individual parts** and an associated system failure.
- It must be possible to calculate the quantity of lubricant needed for a highly precise distribution to suit the operating condition of the drives. The set level must remain constant for an unlimited period of time. → **settable and constantly consistent lubricant distribution**
- The operating state of the lubrication systems must be recognisable at any time by the **monitoring of the main functions**. Malfunctioning should be indicated directly so that repairs can be carried out purposefully and in as short a time as possible.

Optimum lubrication is attained only if the lubricant is distributed evenly over the full tooth flank width. The overall spray pattern depends on how the nozzles are arranged. The required number of nozzles are aligned onto the lubrication point to suit the tooth flank width. It is customary to use nozzles with flat jet inserts. The spray pattern shows an elliptical form. That means however that the specific lubricant concentration decreases towards the outside (Fig. 10).

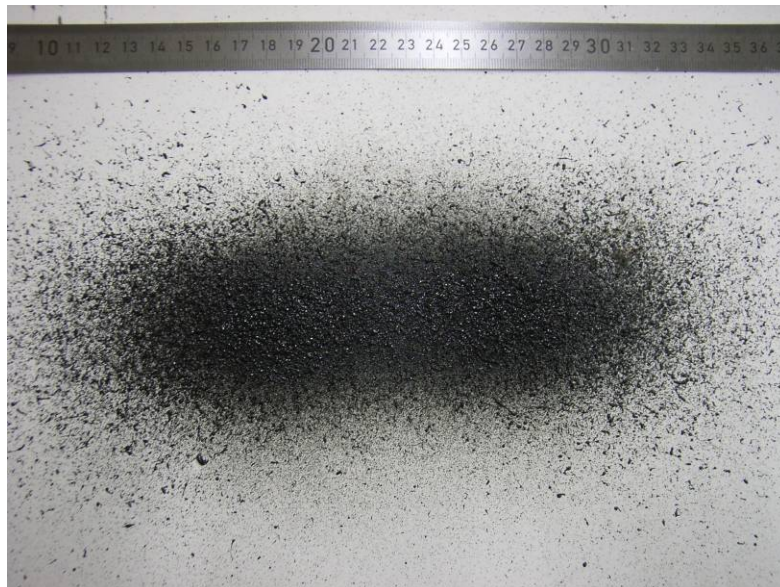


Fig. 10: Spray pattern of a flat-jet SDU spray nozzle



#### 4. REQUIREMENTS FOR THE SPRAYING LUBRICATION SYSTEMS (continuation)

For this reason the nozzles are arranged in such a way that the spray patterns extend over the edge zones. This ensures a sufficient concentration of lubricant over the entire tooth flank width (Fig. 11).

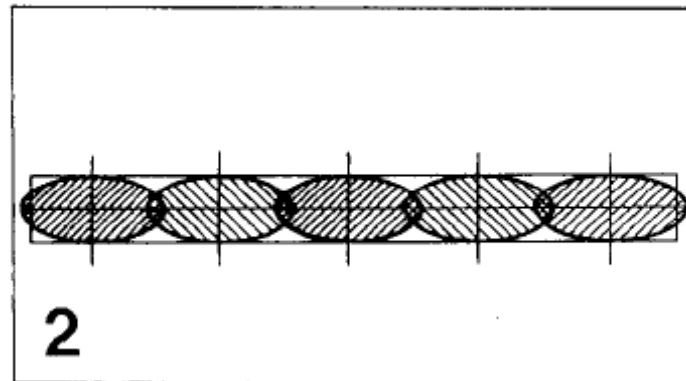


Fig. 11: Sketch of spray pattern extending over edge zone (with overlapping)

Since the outsides of the spraying angles are diverted by unstable currents, the spray pattern is improved optically by turning the nozzle inserts so that they no longer extend beyond the edge zones but have staggered surfaces (Fig. 12). This arrangement has been taken into account already on the pre-mounted spraying stations.

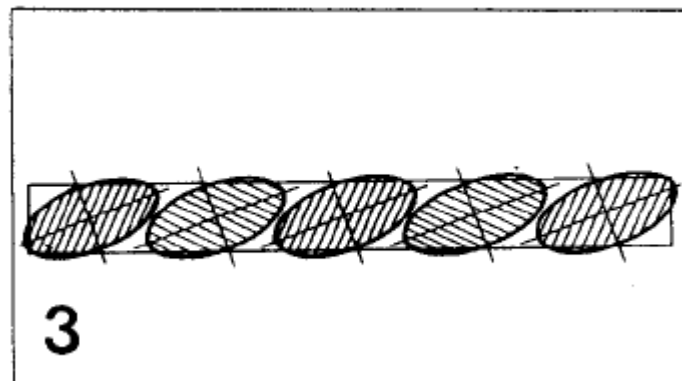


Fig. 12: Outlined spray pattern with edge zone covering (without overlapping)



## 5. FUNCTIONING OF THE SPRAYING LUBRICATION SYSTEMS

The individual components in the spraying lubrication systems described already are explained in the following with the aid of three examples as a cohesive system.

### 5.1 Simple systems for spraying lubrication with a nozzle

The “simple” system consists only of components absolutely necessary for the system to function. This shows an intentionally inexpensive alternative. To make it easier to understand, the function is presented in a diagram, with electrical feed pump (Fig. 13) and pneumatic feed pump (Fig. 14).

#### System 1:

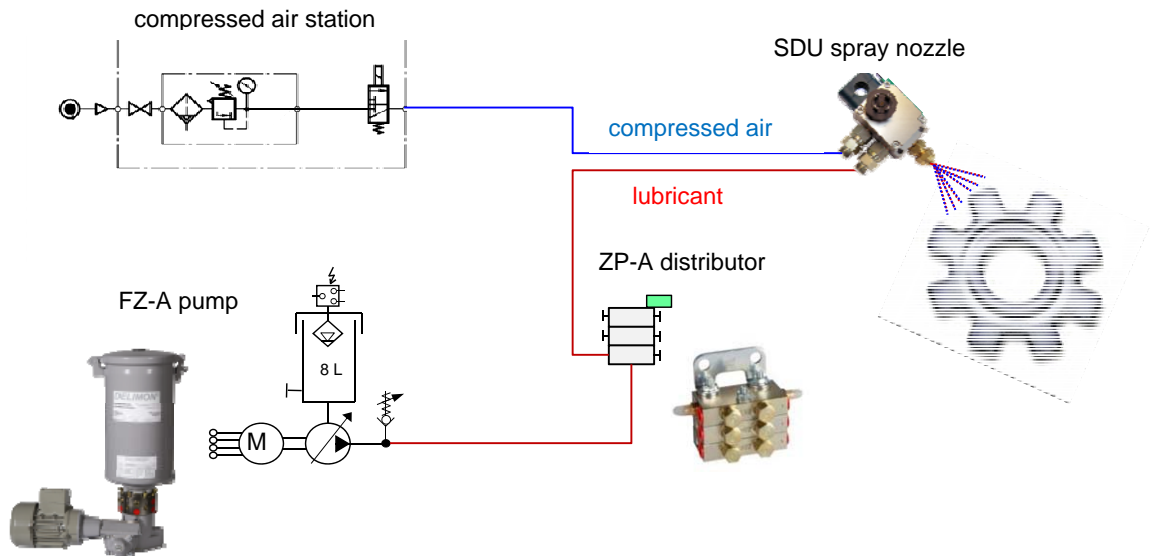


Fig. 13: Simple system with electrical pump

#### System 2:

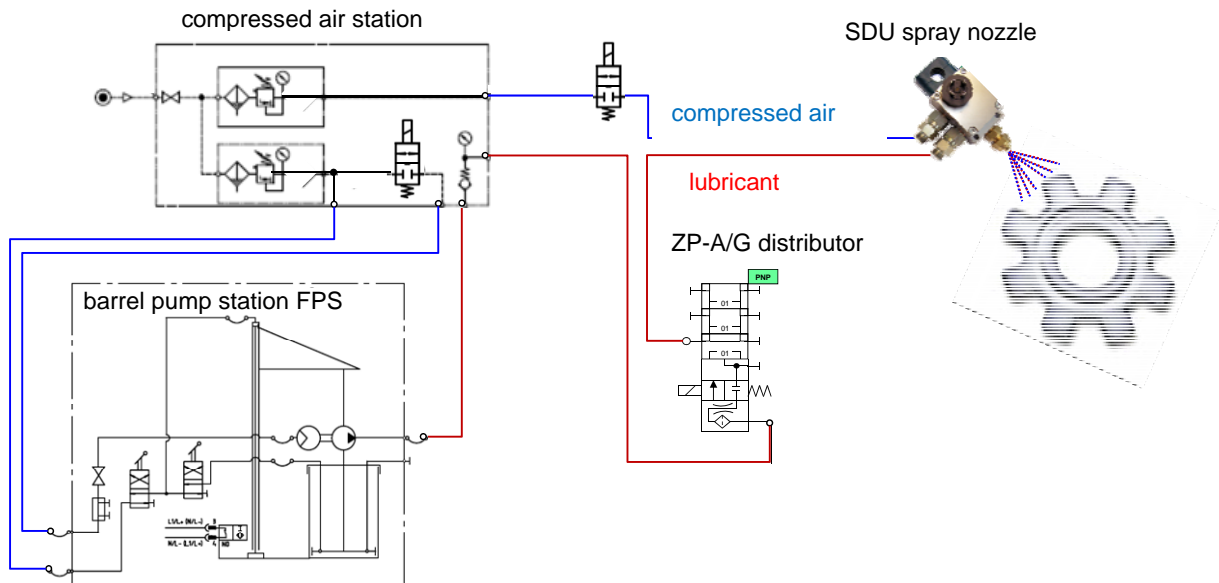


Fig. 14: Simple system with pneumatic pump



## 5. FUNCTION OF THE SPRAYING LUBRICATION SYSTEMS (continuation)

### 5.1.1 Construction of system 1

This system essentially consists of the **FZ-A** feed pump, an **NU-A** pressure relief valve and a **ZP-A** progressive distributor with an initiator to supply lubricant. On the compressed air side we find the compressed air control panel with shut-off valve and filter regulator.

The **lubricant** and **compressed air** lines are attached to the spray nozzle. The equipment also includes electrical switchgear, which is not shown however. It is to control the spraying lubrication systems in accordance with pre-set pause times. The spray nozzle is fastened by means of an auxiliary construction at the necessary distance from the gear's drive pinion. For clarity and to facilitate inspection, the other parts of the system are arranged close to the spray nozzles.

### 5.1.2 Construction of system 2

The system essentially consists of the **FP-S** pneumatic barrel pump, a **ZP-A/G** progressive group lubrication distributor with initiator and attached solenoid valve to supply lubricant. On the compressed air side we find the compressed air control panel with shut-off valve, 2x filter regulators, a throttle and solenoid valve. A further solenoid valve is located outside the control panel in the compressed air pipe for the spray nozzle.

The **lubricant** and **compressed air** pipes are connected to the spray nozzle and barrel pump. The other components correspond to those in system 1.

### 5.1.3 Functioning of system 1

After the end of the set pause time the feed pump is switched on so that it delivers the lubricant to the distributor, which feeds the lubricant in metered quantities into the spray nozzle. After a distributor circulation registered by the initiator, the control switches the feed pump off and the solenoid valve on the compressed air control panel is opened. The compressed air can now flow to the spray nozzle and spray the lubricant already stored in the spray nozzle onto the tooth flanks. The spraying duration is limited by the pre-programmed time. As soon as the signal arrives from the distributor initiator, the pause time begins anew. If a blockage occurs in the distributor, the pressure relief valve protects the feed pump from an overload. The method for determining settings described under point 5.2 can be adopted for this system too.

### 5.1.4 Functioning of system 2

After the end of the set pause time the pneumatic feed pump delivers by opening the solenoid valve at the ZP-A/G distributor. This feeds the metered quantities of lubricant into the spray nozzle. After a distributor circulation registered by the initiator, the solenoid valve at the ZP-A/G distributor closes so that the barrel pump automatically stops the lubricant delivery by blocking the line, whereupon the solenoid valve opens in the compressed air pipe for the spray nozzles. The compressed air can now flow to the spray nozzle and spray the lubricant already stored in the spray nozzle onto the tooth flanks. The spraying duration is limited by the pre-programmed time. As soon as the signal arrives from the distributor initiator, the pause time begins anew. The method for determining settings described under point 5.2 can be adopted for this system too.

## 5. FUNCTIONING OF THE SPRAYING LUBRICATION SYSTEMS (continuation)

### 5.2 System for spraying lubrication with nozzles on a spraying station, completely monitored and heated

The systems with pre-assembled spraying stations are used for installations with heavy-duty gearing (e.g. cement mills, roller hearth furnaces). Since large quantities of lubricant have to be applied continuously onto the pinions here, barrel pumps are used as standard in these installations. Accordingly the lubricant is delivered directly from a commercial container (200-litre barrel).

Apart from the components necessary for operation, optional extensions are recommended in these systems: the optional heating makes spraying special lubricants easy at ambient conditions  $< 5^{\circ}\text{C}$  too. The function monitoring by sensors in the supply of air and lubricant minimises the risk of failure in production for system operators.

The mode of operation is shown in the following diagram and described under point 5.2.4.

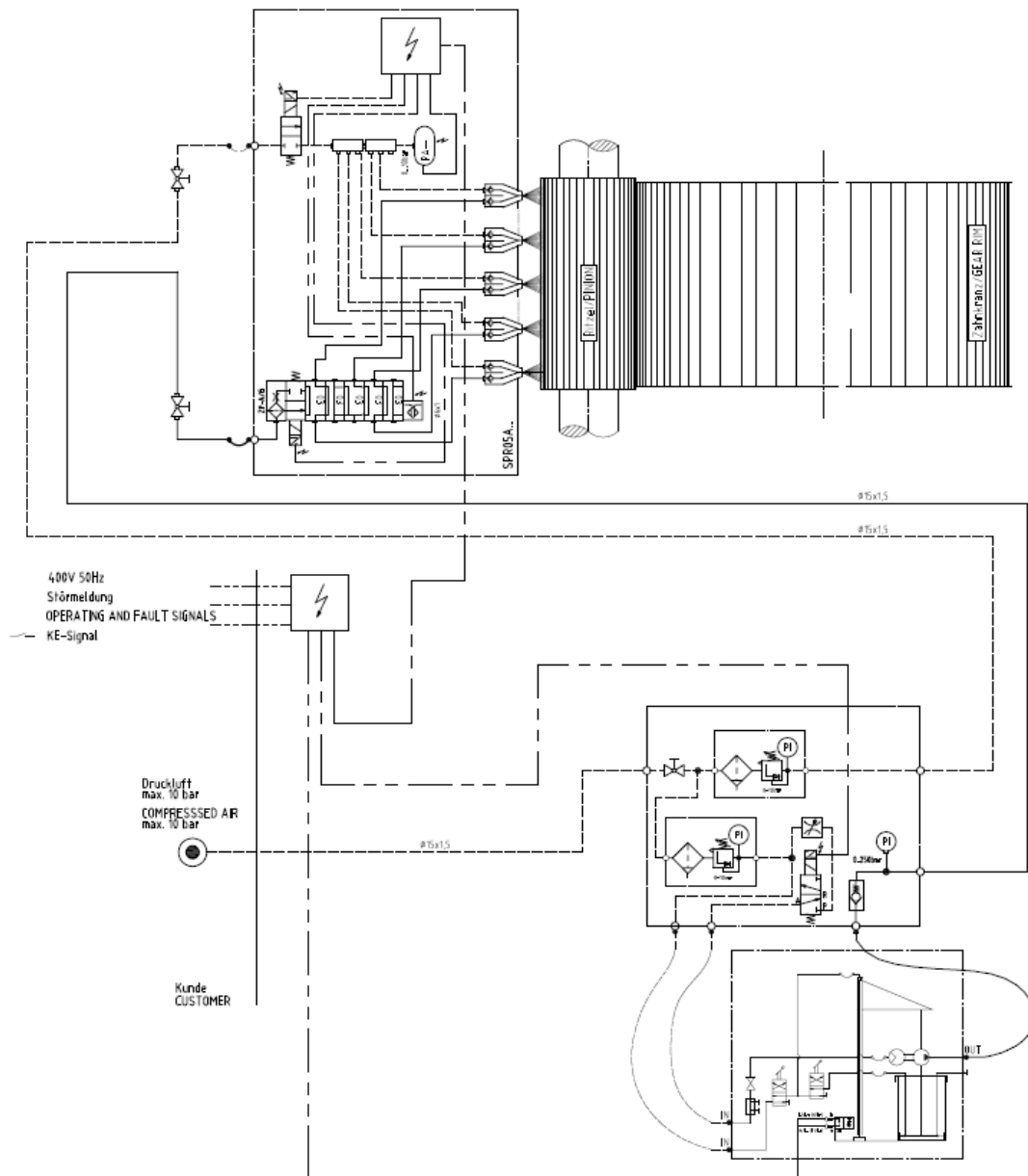


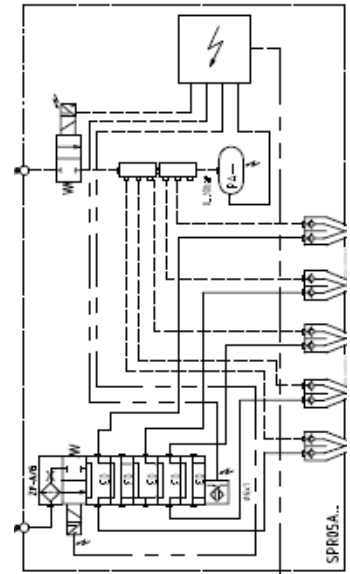
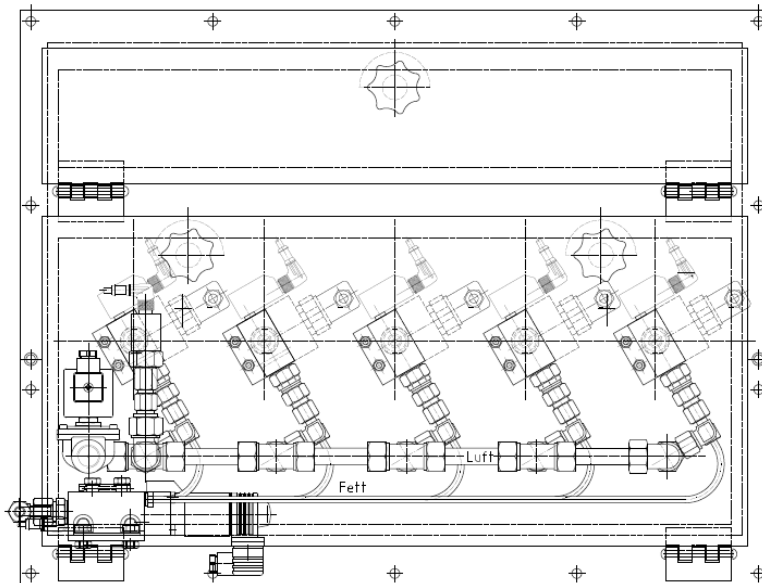
Fig. 15: Diagram showing the FP-S pneumatic barrel pump and SPU spraying lubrication station for 1 pinion with monitoring and heating



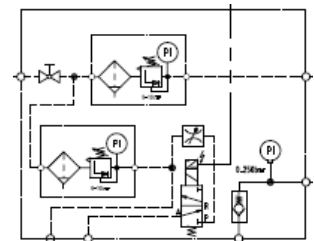
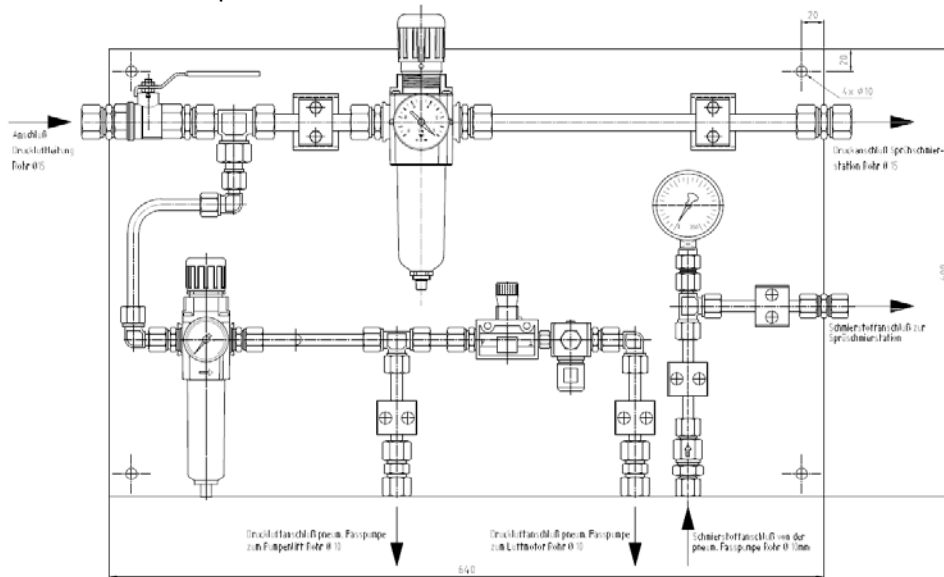
## 5. FUNCTIONING OF THE SPRAYING LUBRICATION SYSTEMS (continuation)

The individual assemblies are shown in the following pictures so that they can be understood more easily:

SPU spraying lubrication station



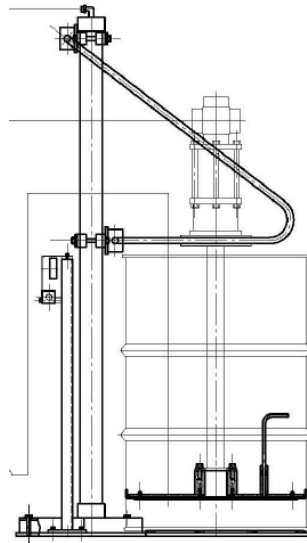
- DLS compressed air control unit





## 5. FUNCTIONING OF THE SPRAYING LUBRICATION SYSTEMS (continuation)

- FPS pneumatic feed pump



The following practical example is used to explain how this system is used.

### 5.2.1 Task definition

The single pinion drive of a cement mill is to be run in and also finally operated with an adhesive lubricant: width of tooth face  $b = 700$  mm, gear rim diameter  $d = 8000$  mm.

### 5.2.2 Calculation of the system values

The reference values for the adjusting data and lubricant quantities to operate the spraying lubrication systems for a single pinion drive can be calculated as follows with the calculation sheets under: <http://www.bijurdelimon.com/> --> Technology 1x1 --> spraying lubrication systems --> Downloads or calculated as follows:

Key:

$Q_n$  = max. amount of lubricant needed per hour when running in  
 $b$  = width of tooth face in mm  
 $D$  = gear rim diameter in mm,  
 $k$  = load factor  
 $X$  = spraying cycles per hour  
 $Q_v$  = total delivery quantity of the distributor per spraying cycle in  $\text{cm}^3$   
 $T_i$  = spraying interval in s

Number of nozzles / tooth width [b]:	
1 nozzle	= bis 275 mm
2 nozzles	= 276 – 325 mm
3 nozzles	= 326 – 475 mm
4 nozzles	= 476 – 575 mm
5 nozzles	= 576 – 725 mm
6 nozzles	= 726 – 850 mm

The following formula is used to calculate the example:

Lubricant required:

$$Q_n = \frac{b \times d \times k}{10,000} = \frac{700 \times 8000 \times 1}{10,000}$$

$$Q_n = 560 \text{ cm}^3/\text{h}$$



## 5. FUNCTIONING OF THE SPRAYING LUBRICATION SYSTEMS (continuation)

5 spray nozzles are used to ensure that the lubricant is distributed reliably over the entire pinion width,. Accordingly the distributor has 5 outlets and a delivery quantity of  $5 \times 0.6 \text{ cm}^3 = 3 \text{ cm}^3$  ( $Q_v$ ) per circulation (1 lubrication cycle). About  $0.6 \text{ cm}^3$  is fed into each nozzle per distributor circulation. This quantity of spray lubricant ensures an even droplet formation on the tooth flanks.

Spraying cycles per hour:

$$X = Q_n/Q_v$$

$$X = 560/3$$

$$X = \mathbf{187 \text{ cycles per hour}}$$

Spraying interval in s:

$$T_i = 3.600/X$$

$$T_i = 3.600/187$$

$$T_i = \mathbf{19}$$

T1 = Pause time relay: spraying interval of  $T_i$  minus 0.5 s

T2 = Spraying time relay: at a spraying interval of  $T_i$  20 s: 2 s,  
at a spraying interval of  $T_i$  30 s: 3 s,  
over a spraying interval of  $T_i$  30 s: 4 s

T3 = Monitoring time relay:  $T_2 + 50\%$

The system in columns 4 - 6 of the table can be calculated using the previously acquired data as a basis.

1 Operating state	2 Duration [h]	3 Factor k	4 $\text{cm}^3/\text{h}$ ( $Q_h$ )	5 Number of spraying cycles per hour (X)	6 Spraying interval in s ( $T_i$ )
Running in	350	1.00	560	187	19.0
Transition	24	1.00	560	187	19.0
1 <sup>st</sup> reduction	24	0.75	420	140	26.0
2 <sup>nd</sup> reduction	24	0.50	280	94	38.0
3 <sup>rd</sup> reduction	$\infty$	0.38	213	71	51.0

The mechanical timing in the spraying lubrication system was taken into account in the times indicated in order to rule out overlapping.

On the compressed air side the system was set to:

Spraying pressure: 3 - 5 bar,

Actuating pressure: 1.7 bar

This results in a max. air consumption during running in:

$$Q_n \times T_2) / 8 \text{ [l/min.]}$$

$$(560 \times 2) / 8 = \mathbf{140 \text{ l/min}}$$



## 5. FUNCTIONING OF THE SPRAYING LUBRICATION SYSTEMS (continuation)

Adding a **safety margin of 40%**, a compressor capacity of approx. 200 l/min. is necessary. The following presents the view from the calculation sheet (Fig. 16):

### Calculation sheet for spray lubrication single pinion drive

<b>1. Data of the pinion</b>		(*) - Value for calculation ist for mills at least 6.000 mm					
width of pinion	350 mm	gear rim diameter real value	4.500 mm				
		gear rim diameter calculated	4.500 mm (*)				
<b>2. Data of the spray nozzles</b>							
Type	SP-A	Number	3				
grease feed volume from the distributor (per nozzle and cycle)			0,4 cm <sup>3</sup>				
angle of the jet stream	x	120 °	y 30 °				
Air cons. (bei bar)	3,0	3,5	4,0	4,5	5,0	5,5	6,0
a) in Nm <sup>3</sup> /h	14,70	16,75	18,80	20,85	22,90	25,00	27,10
b) in NI/s	4,08	4,65	5,22	5,79	6,36	6,94	7,53
Pressure of spray air (bar)	4,0		Consumption per nozzle (NI/s)	5,22			
<b>Arrangement of the nozzles:</b>				width of jet at the pinion surface			
Distance nozzel outlet to pinion	180,0 mm		x	624 mm			
Distance nozzel to nozzel	116,7 mm		y	96 mm			
Distance nozzel to pinion outside	58,3 mm						
<b>3. Resulting grease consumption for different modes</b>				Divider cycle time (s)			
				2,00			
Mode	duration [Bh]	reduction factor	grease [cm <sup>3</sup> /h]	ST [pro h]	INT [s]	SZ [s]	PZ [s]
start phase	350	1,00	158	132	27,0	3,0	25,0
pass over phase	24	1,00	158	132	27,0	3,0	25,0
1. Reduction	24	0,75	118	99	36,0	4,0	34,0
2. Reduction	24	0,50	79	66	55,0	4,0	53,0
3. Reduction	-	0,38	60	50	72,0	4,0	70,0
Hints:							
Make setting of pause time (PZ) so, that the summary of pause time (PZ) and of the time wich is necessary for a cycle of the divider (divider cyle time) is in accordance with the intervall (INT), so that the necessary no. of lube cyles (ST) will be reached. Attention: Spraytime(SZ)<Pausetime (PZ)							
<b>4. Resulting air consumption for different modes</b>							
Data of barrel pump BF-G (i=50:1)	feed volum per double stroke (DH)		12,00 cm <sup>3</sup>				
	primary air pressure set to		3,20 bar				
	air consumption per double stroke		2,24 NI				
Mode	Pump (DH/h)	Air consumption (NI/min)			QK NI/min		
		Pump	Nozzles	summary			
start phase	13,13	0,49	103,40	103,89	167,00		
pass over phase	13,13	0,49	103,40	103,89	167,00		
1. Reduction	9,84	0,37	103,40	103,77	167,00		
2. Reduction	6,56	0,25	68,93	69,18	111,00		
3. Reduction	4,99	0,19	52,22	52,41	84,00		
Safety factor for the choose of the compressor (QK)				1,60			

Fig. 16: Calculation sheet for designing the spraying lubrication system



## 5. FUNCTIONING OF THE SPRAYING LUBRICATION SYSTEMS (continuation)

### 5.2.3 System construction

The compressed air station is connected to the compressed air network. To control the spraying lubrication system, the following components are contained in the compressed air station:

1x shut-off valve, 2x filter regulators, 1x throttle, 1x 3/2-way solenoid valve and 1x manometer. Between the shut-off valve and the filter regulator for the spray air a line with filter regulator, throttle and 3/2-way solenoid valve to supply compressed air to the pump branches off. Furthermore the pressure pipe for the lubricant from the pump is connected to the panel so that the system pressure for the lubricant and the compressed air line to the pump can be read off on the following manometer.

The operating pressure required by the barrel pump is set by means of the regulator and can be read off on the associated manometer. The pump is equipped with a monitor of minimum contents in order to be able to report a need for a barrel change in good time. The compressed air and lubricant connection of the compressed air station on the outlet side is joined to the opposite connections on the spraying lubrication station. This consists essentially of the lubricant distributor with initiator and solenoid valve, pressure switch min (air) - set at 2 bar, solenoid valve for the spray air and the spraying nozzles and a terminal box.

The spraying nozzles can be equipped with heating as well as optical or electrical monitoring, which indicate malfunctioning through the electrical control whenever a monitoring signal fails to arrive. The electrical switchgear serves to control and monitor the entire spraying lubrication system.

### 5.2.4 Mode of Operation

When the spraying lubrication system is switched on, the set pause time starts. At the end of this pause time the solenoid valve for supplying compressed air to the pump enters the open flow passage position, whereby the pump starts up and delivers the lubricant in the direction of the spraying lubrication panel. At the same time after the end of the set pause time the solenoid valve on the distributor is actuated. The solenoid valve enters into the open flow-passage position and the lubricant delivered by the pump flows into the distributor. After a full circulation of the distributor a 0.6 cm<sup>3</sup> quantity of lubricant is stored in each spraying nozzle. After the full circulation the initiator attached to the distributor responds, the solenoid valve of the distributor and the solenoid valve for compressed air to the pump return to their basic positions. This interrupts the flow of lubricant into the distributor. At the same time the solenoid valve for the spray air is switched into the open flow-passage position and the lubricant is blown out of the nozzles in a time lasting up to 4s and sprayed onto the tooth flanks. When the solenoid valve for the distributor opens, the set pause time begins to count again.

To conduct a visual inspection of the correct functioning, the nozzle flap can be swung out from the base plate. A spraying-pattern-and-adjusting template is fastened to the base plate in the bores provided for it. By spraying onto this template an external spraying pattern can be produced for checking and adjusting the nozzles. The upper inspection flap can be opened while the system is in operation in order to facilitate visual monitoring.

The mechanical functioning of the system is monitored on the grease side by the initiator at the distributor and, if available, by the initiator at the spraying nozzle. If these do not respond within a set monitoring time once the system is switched on, a fault message is sent. The distributor monitoring can also be monitored visually by means of the movement indicator, which operates the initiator.

On the air side the functioning is monitored by means of the min. pressure switch and, if available, by the initiator at the nozzle. If the pressure does not rise above the set monitoring pressure once the solenoid valve is opened, a fault message is sent also. The lubricant can be delivered directly after the end of the pause time since the line between the barrel pump and solenoid valve at the distributor is always open. As the lubricant delivery is interrupted directly in front of the nozzles by the solenoid valve, any undesirable dripping from the nozzles is ruled out.

There is never any pressure on the compressed air side in the barrel pump during downtime and pause times and this prevents the barrel emptying if there is a break in the line.

## 5. FUNCTIONING OF THE SPRAYING LUBRICATION SYSTEMS (continuation)

### 5.3 System for lubricating double pinion drives:

The system described under Chapter 5.2 is used with the same technology to lubricate double pinion drives too. Each meshing is assigned its own **SPU** spraying lubrication station.

The mode of operation is as described in Chapter 5.2.4 and shown in the following diagram.

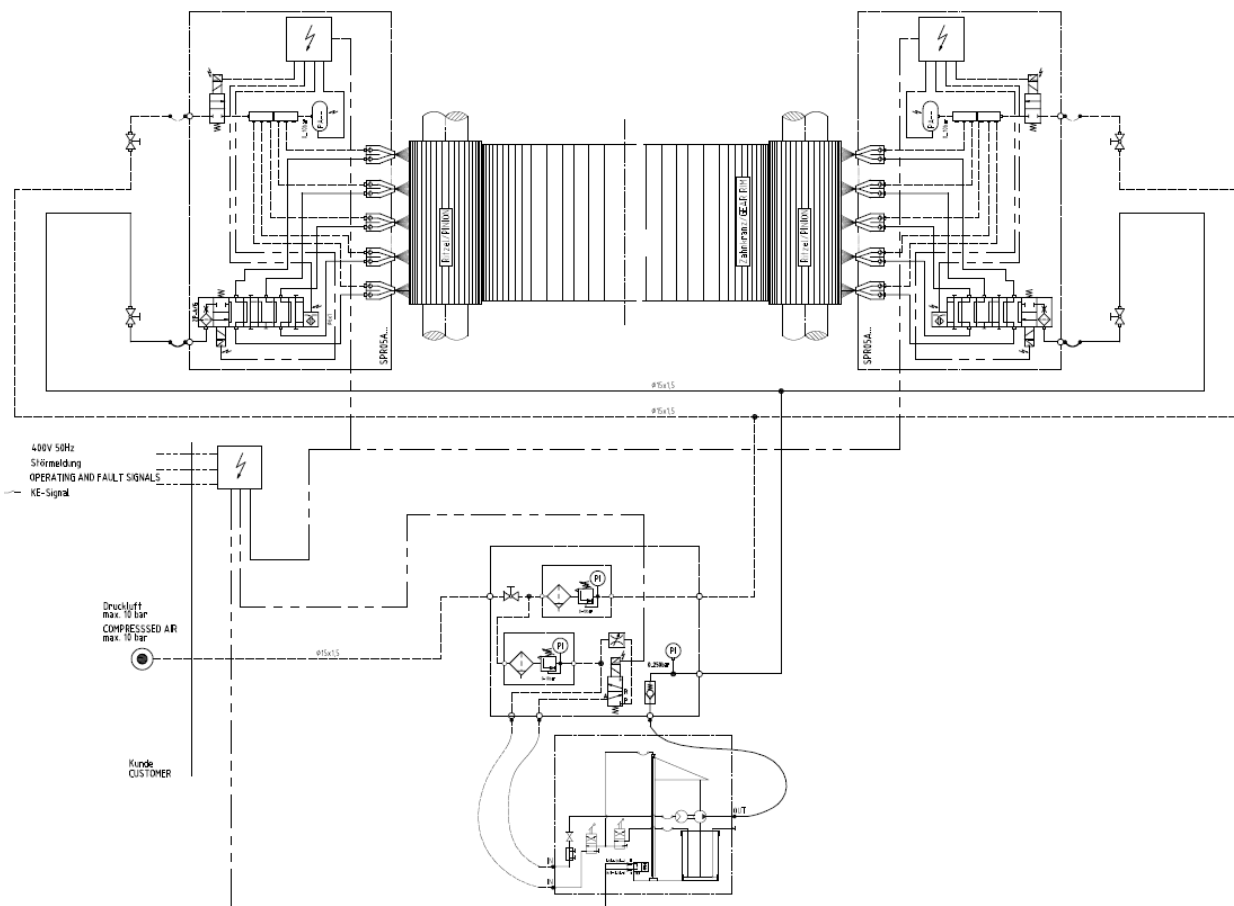


Fig. 17: Diagram of double pinion system

The system values are double those in Chapter 5.2.2. Since both meshings are sprayed at the same time, the X values (spraying cycles per hour) and  $T_i$  (spraying interval in seconds) do not change.



## 6. INSTALLATION

The spraying lubrication stations are installed in appropriate cutouts in the gear covers. It must be ensured during assembly that the spraying angle in accordance with the following drawing is observed and that the spraying distance "A" of 150 to 200mm between the tip of the nozzle and the pinion is taken into account.

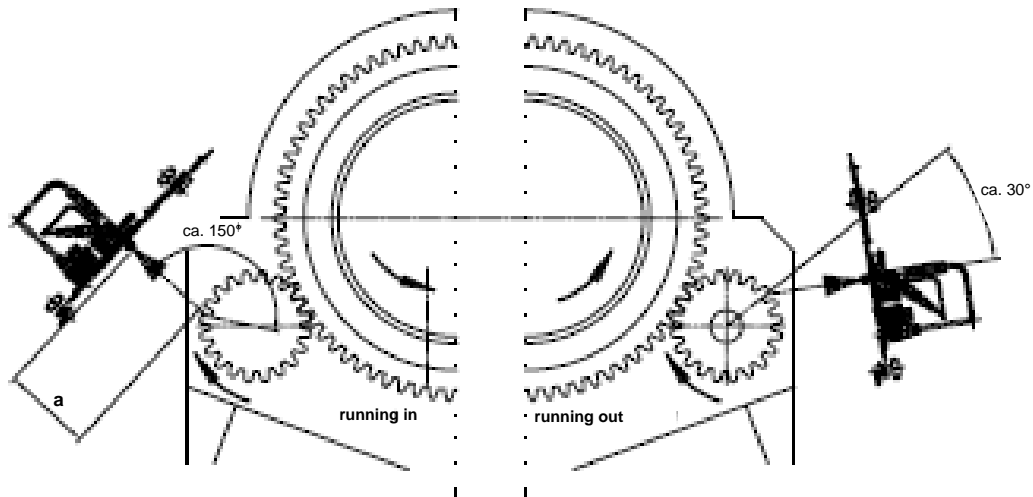


Fig. 18: Arrangement of the **SPU** spraying lubrication station

In most cases spraying is done onto the load-bearing tooth flanks of the pinions. Since these have a higher number of revolutions than the gear rims, this ensures the best possible distribution of lubricant onto the circumference even in short spraying times and so there is always a sufficient amount of lubricant in the tooth engagement. The spraying direction is from top to bottom in order to prevent old lubricant and impurities depositing on the spraying lubrication stations.

As the lubricant line shut-off facility is before the spray nozzles, the line always remains open so that the lubricant can be delivered directly.

Like other installations, spraying lubrication installations must be regarded as machines and must therefore be included in companies' preventative maintenance systems.

