

# Engine Indicator S1

## Operating instructions



## General



This operating manual provides instructions on how to use this product properly, effectively and safely to the intended purpose. Please, do read all instructions, notes on danger and warning attentively. Please follow all safety hints and precaution notes in order to avoid damages to people or property during the work process. The company Leutert cannot be responsible for damages or injuries resulting from unsafe product use, incorrect product operation or lack of maintenance.

The operating manual is directed mainly to technically trained personnel. In case of uncertainty regarding the safety hints or the operation, please do not hesitate to contact the Leutert company for help. Should you notice a faulty description or depiction or if you would like to point out hints for improvement, we are looking forward to hearing from you.

Please keep the operating instructions near the product to have it available if needed. Make sure that the instructions are protected from dirt and moisture.

Explanation of the different symbols:



### DANGER

Immediate danger is possible causing severe injuries or even death if you do not follow the instructions given.



### WARNING

If you do not follow the warning, dangerous situations may occur leading to severe injuries or even death.



### CAUTION

Follow the instructions carefully, otherwise dangerous situations may occur leading to injuries or damages to property.



### NOTICE

Please follow the recommendations and instructions for a correct and flawless operation of the device or measuring system.

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## Safety Instruction



**DANGER!** Before using indicator, open indicator valve or cock, blow out any dust, and close it again. Hot gas and particles may be ejected. **WEAR GLOVES AND SAFETY GLASSES!**

## Application and Product Description

The Leuter Indicator Type S1 can handle higher speeds and is, therefore, the choice device where the helical spring indicators Type 50Z1 and 30/1 are no longer suitable.

It is a mechanical indicator that still records a clear diagram at speeds above  $800 \text{ min}^{-1}$  and pressure change rates exceeding  $24000 \text{ bar/sec}$ .

Fig. 1 shows the schematic outlines of the Leutert bar spring indicator drawing particular attention to its principal features. Contrary to the indicators types 50Z1 and 30/1, the type S1 indicator has a bar spring (2) instead of a double-coiled helical spring which - being a body of almost equal resistant - is stressed by bending. The special design of its indicator places its natural frequency far above that of indicators using a helical spring. Consequently, type S1 indicator permits perfect diagrams to be obtained at speeds up to about  $2400 \text{ min}^{-1}$  and pressure change rates up to about  $32000 \text{ bar/sec}$ .

The number of natural frequencies of the indicator is calculated about  $(340/\sqrt{f}) + 40$ ,  $f$  = scale of the bar spring to be used in  $\text{mm/bar}$ , referring to the 1/1 piston.

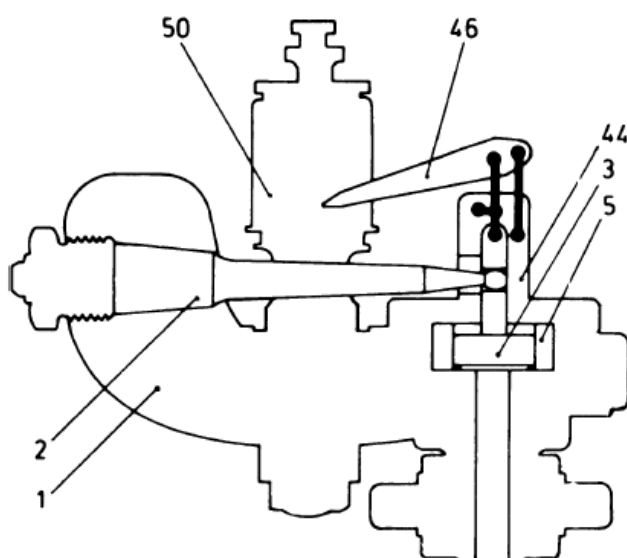


Fig. 1 - Schematic drawing

A piston of 1/1 with cylinder and the corresponding spring (see spring table) permits the recording of pressures up to 100 bar. Therefore, a change of piston is rarely required for this indicator when taking ordinary engine diagrams, contrary to the instruments applying a helical spring.

When using a piston and cylinder of 1/2, pressures up to max. 200 bar can be recorded. For precision measurements within the absolute pressure range of approx. 1 bar, for example for taking partial diagrams of the suction and exhaust stroke, the indicator can be equipped with a 2/1 piston and cylinder (refer to section „Indicator spring“).

The pressure range from 200 bar up to 2000 bar can be covered by our indicator type S1.

## Technical specifications

Measuring range	:	see spring table below
Engine sizes	:	up to $n = 2,000$ rpm or max. $dp/dt = 32 \times 10^3$ bar/sec
Max. diagram	:	25 mm / 60 mm (height / length)
Drum diameter	:	30 mm
Paper size	:	115 mm x 35 mm
Dimensions	:	140 mm x 150 mm x 100 mm
Weight	:	2.6 kg (without wooden box) 6.0 kg (with wooden box)
Natural frequency/sec	:	$(340/\sqrt{f}) + 40$ (f = measuring scale)
Standard connection	:	W27 x 23.75 dia 10 tpi (W1-1/16")

Table of Indicator Springs Type S1													
Piston size	Ø mm	Part-No. 4631.0.71.	01000	02000	03000	04000	05000	06000	07000	08000	09000	10000	11000
		Spring-No.	S / 5 bar	S / 10 bar	S / 16 bar	S / 24 bar	S / 32 bar	S / 40 bar	S / 50 bar	S / 60 bar	S / 70 bar	S / 80 bar	S / 100 bar
1/1	20.27	Scale mm/bar max. pressure / bar	3.5 6	2 10	1.25 16	1 24	0.75 32	0.6 40	0.5 50	0.4 60	0.35 70	0.3 80	0.25 100
2/1	28.67	Scale mm/bar max. pressure / bar	7 3	4 5	2.5 8	2 12	1.5 16	1.2 20	1 25	0.8 30	0.7 35	0.6 40	0.5 50
1/2	14.38	Scale mm/bar max. pressure / bar	1.75 12	1 20	0.625 32	0.5 48	0.375 64	0.3 80	0.25 100	0.2 120	0.175 140	0.15 160	0.12 200
1/5	9.06	Scale mm/bar max. pressure / bar	0.7 30	0.4 50	0.25 80	0.2 120	0.15 160	0.12 200	0.1 250	0.08 300	0.07 350	0.06 400	0.05 500

## Spare Parts List

Item	Description	Part No.
1	Spring support	4631.0.11.03100
2	Bar spring	as per spring table
3	Piston 1/1	4632.0.11.10200
4	Piston 1/2	4631.0.11.10200
5	Cylinder 1/1	4632.0.11.00001
6	Cylinder 1/2	4631.0.11.00001
7	Ring nut	4631.0.11.10100
8	Protective cover	4631.0.11.10001
9	Coupling nut	4631.0.11.03205
10	Wedge	4651.0.11.03102
11	Leaf spring	4631.0.11.03001
12	Guide pin	4631.0.11.03103
13	Pressure pin	4631.0.11.03104
14	Screw cap	4631.0.11.03105
15	Stop column	4631.0.11.03106
16	Link bolt, short	4631.0.11.11010
17	Link bolt, medium	4631.0.11.11011
18	Link bolt, long	4631.0.11.11012
19	Swing lever	4631.0.11.11004
20/49	Coupling link	4631.0.11.11006
21	Counter link	4631.0.11.11008
22	Stop disk	4631.0.11.11003
23	Retaining ring	4651.0.11.10004
24	Stop screw	4631.0.11.11003
25	Leaf spring	4631.0.11.12002
26	Knurled nut	4651.0.11.12001
27	Knurled handle	4651.0.11.11400
28	Drum spring	4631.0.11.01004
29	Drum nut	4631.0.11.01002
30	Oil nut	4631.0.11.01003
31	Drum axle	4631.0.11.01100
32	Paper clamp	4631.0.11.01203
33	Drum stopping screw	4631.0.11.01204
34	Drum screw	4631.0.11.01205
35	Drum cover	4631.0.11.01001
36	Nut M10 DIN 934	Mutter M10.0055
37	Nut M10 DIN 439	Mutter M10.0052
38	Screw M3x4 DIN 84	Zschrb M03.0040
39	Screw M2,5x10	Zschrb M02.0161
40	Screw M2,5x4	Zschrb M02.0147
41	Screw M1,7x4	Zschrb M01.0142
42	Locking washer 1,5	Seeg-S RS1.035
43	Spring support with coupling nut compl.	4631.1.11.03000
44	Upper part, compl. 1/1	4632.0.11.10000
45	Upper part, compl. 1/2	4631.0.11.10000

46/47	Recording mechanism	4631.0.11.11000
48	Recording lever compl.	4631.0.11.11100
50	Drum, compl.	4631.0.11.01000
51	Drum cylinder, compl.	4631.0.11.01200
52	Guide roll, compl.	4631.0.11.02000

Indicator spring and wooden scale as per table on page 5.

When ordering spare parts, please specify the serial number of your Indicator and advise the part-no. in question.

### Design

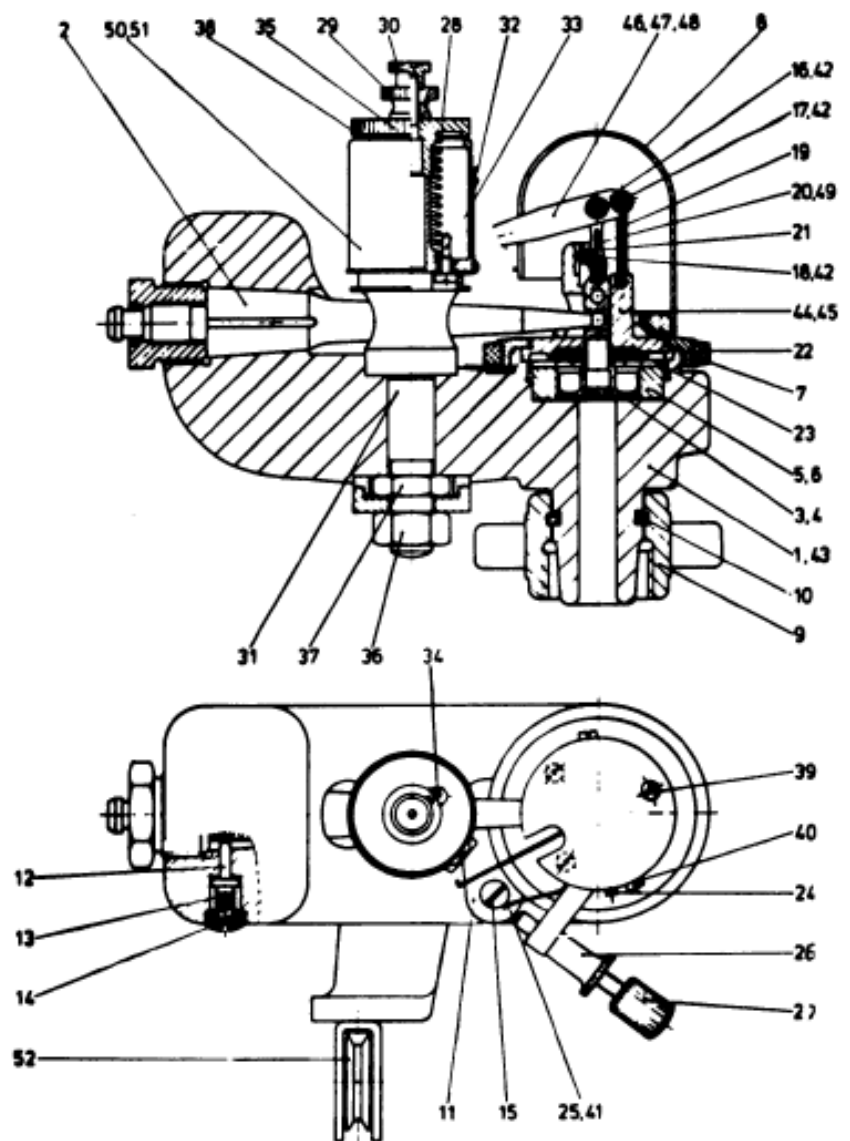


Fig. 2 - Design

## Recording Mechanism

The detachable upper part of the indicator type S1 (fig. 3) forms one single unit with the recording mechanism (46) and piston (3). Cover (8) fastened by 2 screws protects the recording mechanism from being damaged and only the recording lever protrudes from a slot in the cover. For cleaning and oiling the links, take off the cover. We do not recommend dismantling the links, for we abandoned the use of screws to save weight, and the tiny rings securing the bolts cannot be mounted without the application of special tools. Should the recording mechanism be damaged, it is advisable to return the whole upper part or rather the entire indicator to our works.

When inserting the upper part, first introduce the piston in its cylinder, then tighten the ring nut (7) while moving the recording lever up and down. The bent recording lever point which also serves as pencil for recording on the wax-coated paper should touch the drum (50). The pressure of the pencil on the drum is adjusted by turning the knurled nut (26). The leaf spring below the knurled handle causes the recording pencil to be lifted automatically off the drum. Leaf spring (11) arranged laterally below the ring nut serves to prevent self-loosening.

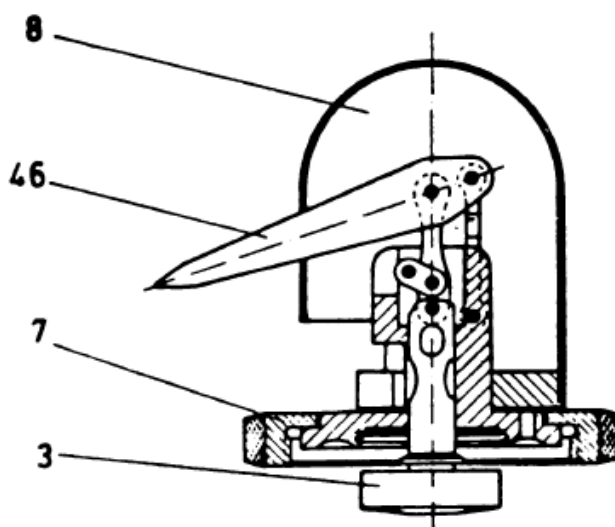


Fig. 3 - Upper-part

## Piston and Cylinder

As already mentioned under section 3, the piston forms one unit with the upper part and is not interchangeable (see fig. 3). Each piston size requires an upper part of its own. For exchanging the cylinder (5) remove the upper part by loosening ring nut (7), then unscrew and exchange the cylinder using the cylinder key supplied as cylinder accessory.

## Indicator Spring

On the type S1, the indicator spring (2) is a bar spring which is clamped at one end into the conical seat of the spring support (1) using an unteachable threaded bush. The spherical point of the spring is seated in a bore of the piston rod. The spring, accurately ground to size, is deflected by the force of the piston, and this deflection is transferred to the recording pencil at the multiplication of 8:1 by the lever system. At a maximum recording height of 25 mm, the piston makes movement of approx. 3 mm only. At the front of the threaded bush the size of the spring is engraved according to the maximum pressure, referred to 1/1 piston. The spring to be used should be selected from the spring table according to the existing maximum pressure. An appropriate scale is supplied with each spring.

Should the maximum pressure be unknown, begin with the strongest spring, selecting the proper one after measuring the pressure of the indicator. In case too weak a spring is selected, it will not do any harm to the indicator since the piston way is restricted by hitting against a stop in the upper part, thus avoiding overloading the spring.

Practically the same thing happens when measuring an absolute pressure of 1 bar abs. with a weak spring. Everything above 1,5 bar - using for example a spring No. S1/1,5 bar and a piston 1/1 - is not recording because the piston is limited by a stop. When inserting the spring, take care that the guide pin (12) in the spring support (1) engages into the groove of the spring cone and that the spherical point is inserted easily into the hole of the piston rod. In order to achieve this, move the upper part of the indicator to and from with the knurled handle, whilst the other hand carefully screws-in the spring. Only once the point of the spring is firmly seated in the hole of the piston rod, the screwed bush should be firmly tightened by the special key in the box.

## Indicator Drum

In view of the high speed this indicator is intended to be used on, the drum of 30 mm dia. with the bar spring extending through the drilled axle is designed with a minimum of mass without sacrifice in strength. The return movement of the drums is effected by a built - in spring (28), the tension of which may be adjusted as desired by turning drum cover (35). After loosening the oil nut (30) and the drum nut (29) above the drum cover, the drum can be drawn off its axle very easily. The drum axle has an elastic drum stop and carries at its lower end, which protrudes out of the spring support, the swiveling cord guide roll (52) for the drum cord.

## **Drive of Recording Drum**

Many engines, particularly the high speed ones for which the bar spring indicator has specifically been designed, do not have indicating rods since for high speeds it would be very difficult to catch the cord. Therefore, in practice diagrams are often drawn by hand.

The drum drive makes it possible to take perfect diagrams also on high speed engines. The drum drive essentially consists of a crank gear with connecting rod and piston; it is a reduced copy of the motor. The piston which drives the indicator drum by a steel band, runs synchronously with the crank shaft of the engine to be tested. Coupling to the engine is effected either directly or by toothed gear or chain wheels. For details refer to special leaflet.

## **Handling and Care of the Indicator**

Always remember, the Leutert bar spring indicator is a high precision instrument that should always be treated accordingly if it is to meet the requirements. Never use sharp polishing material, such as emery paper, polishing paste etc. to clean dirty pistons and cylinders, as the piston clearance would soon exceed the admissible play in the cylinder. The best means to avoid clogging and oil crusts is a careful cleaning with a soft cloth and new oiling of piston with SHC-Mobil-Oil after each application of the indicator (oil bottle in box). After removal of the protecting cover, the links of the recording mechanism should also be oiled now and then with a drop of the same oil. The same applies for the drum bearings by squirting oil into the bore of the drum shaft after unscrewing oil nut (30).

Being very precise measuring springs, the bar springs are to be treated carefully and put back into the recess in the box immediately after use. Blows will alter the scale of the spring. The receiving cone of the springs should always be slightly greased.

## **Technical Advice for Taking Diagrams**

Prior to taking diagrams check whether the indicator is in perfect condition, whether the proper spring according to the expected pressure is applied and whether the ring of the upperpart is tightened firmly.

Furthermore, check whether the drum drive operates properly and whether the drum swings freely without knocking against drum stop. The diagram paper should fit tightly around the drum without wrinkling, for loose paper is torn by the pencil.

Please get accustomed to marking every diagram paper with the respective engine data, such as: serial number and type of engine, number of the cylinders, number of revolutions, load factor etc., besides, serial number of the indicator, size of the spring and piston. These data may be of great importance in case of eventual claims, since the working conditions can only be judged when diagrams can be shown provided with such data.

The indicating channel between engine cylinder and valve of the indicator should be as short and as large as possible and have a diameter of the least 8 mm. Large and short passages are less liable to produce antechamber ignitions or gas oscillations.

The pressure applied to the pencil should be adjusted such as to obtain a fairly visible diagram. Too strong a friction of the pencil will falsify the diagram and may lead easily to a tearing of the paper. The bent point forming the pencil of the recording lever to record on waxed paper may be sharpened, in case of requirement, by a polishing file and any burrs should be taken off the new point by polishing paper.

When taking diagrams, engage the drum drive; draw the zero line, quickly open the valve and press the pencil momentarily on the drum. According to the number of revolutions of the engine, the pencil should rest on the paper a very short time only, otherwise bundles of diagrams are produced. Close the valve again immediately. Considering the high stress of the recording mechanism, the life of the indicator would be shortened if the valve is left open too long. This refers also to the drum drive. After having finished taking diagrams, let the indicator cool down, unscrew the spring, take off the upper part, clean piston and cylinder and oil them, also oil the links, then assemble the indicator again and put it back in its box.

Our Engineering Service will gladly give you recommendations.

### **Leutert Indicators, Accessories and Testing Equipment**

- Model 50Z1 for low pressure-change rates
- Model 30/1 for high pressure-change rates
- Peak Pressure Indicator MSI-3
- Digital Pressure Indicator DPI-2
- Valves, cord guide rolls, diagram paper, cord and steel tape, indicator cord, spring testing devices

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Issued: 9 December 2008