LEFFER WATERLESS GASHOLDER

SYSTEM M·A·N

STAHL- UND APPARATEBAU

HANS LEFFER GMBH

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LEFFER works at Saarbrücken-Dudweiler/Germany

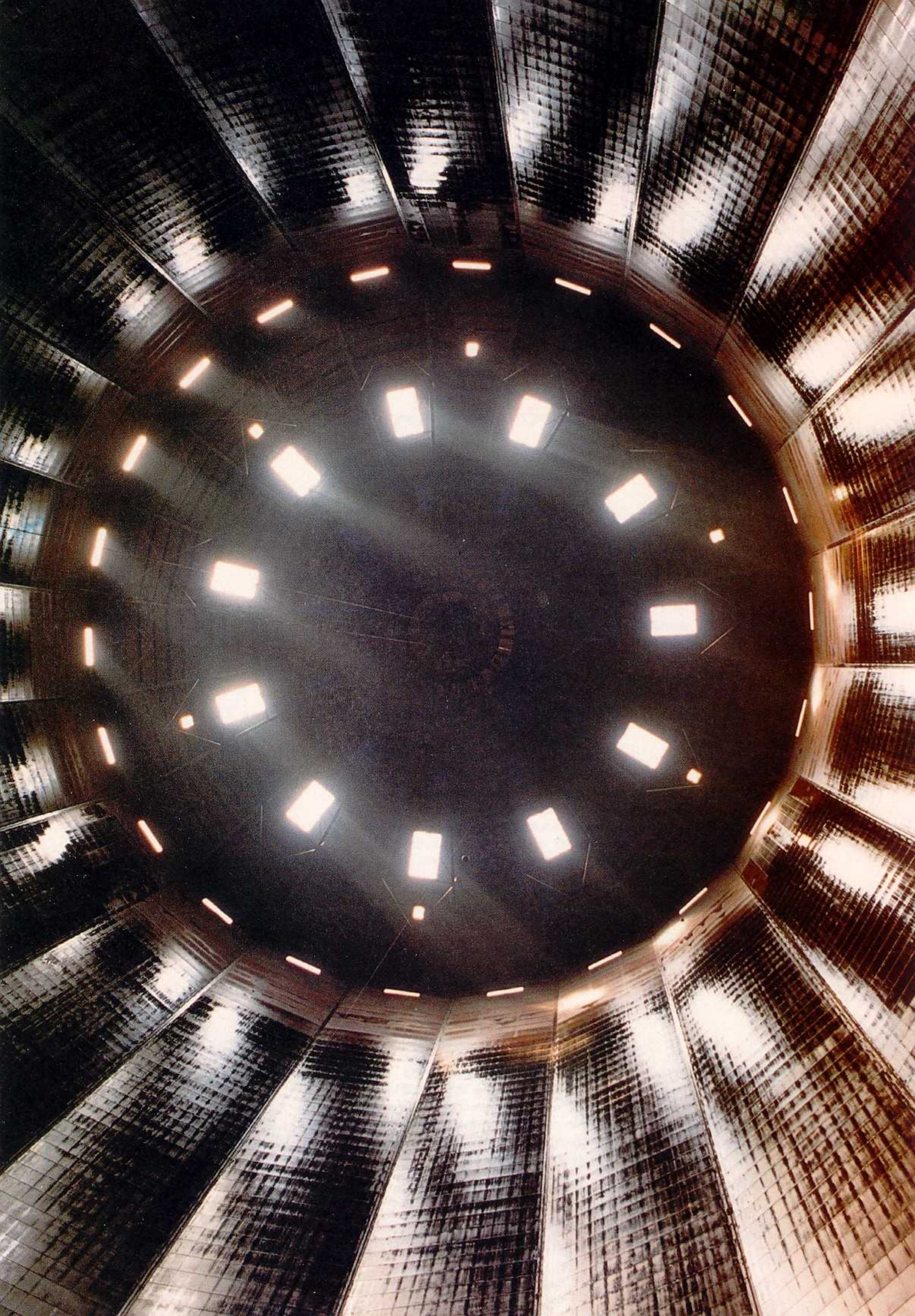
Photo on front page:
LEFFER Gasholder Type MAN approx. 100.000 cu. m.
at Thyssen Stahl, Duisburg/Germany

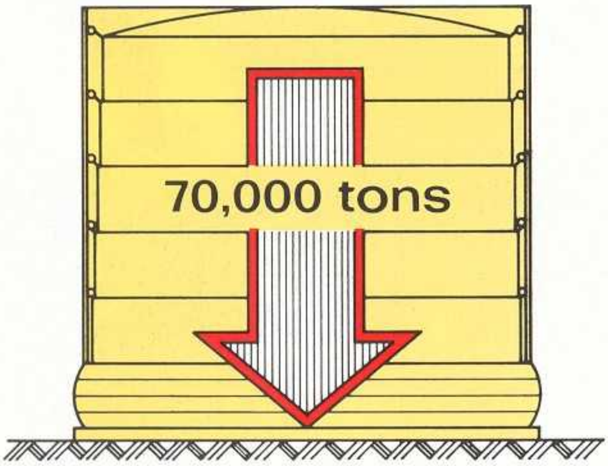
LEFFER

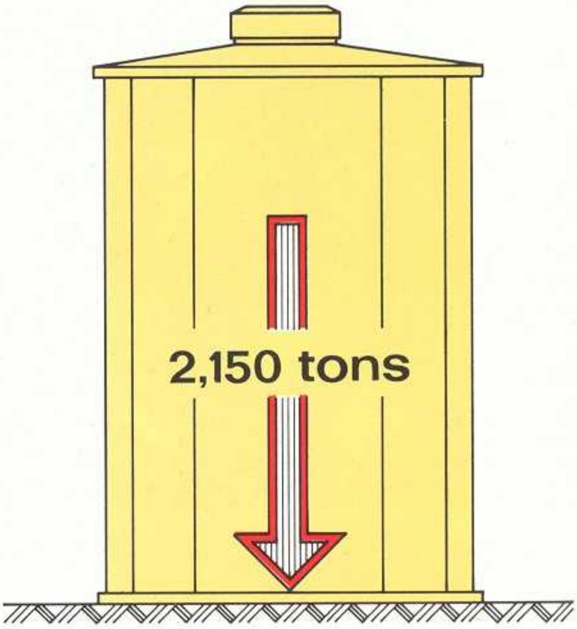
LEFFER - WATERLESS GASHOLDER
SYSTEM M·A·N

LEFFER Gasholder Type MAN approx. 100.000 cu. m.
at Thyssen Stahl, Duisburg/Germany

WALL AND ROOF CONSTRUCTION
OF A PISTON GASHOLDER
(INSIDE VIEW)







THE PROBLEM:

The MAN waterless (piston type) gasholder was developed as the result of a wide demand for a gasholder of relatively light weight which would combine large effective capacity with dependable operation and modest outlay for foundations, even under poor or erratic subsoil conditions such as may be encountered in mining areas.

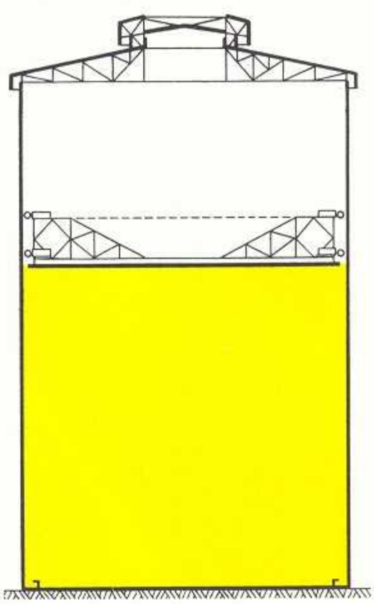
THE SOLUTION:

Adoption of the proved elements of telescopic gasholder construction - in particular the positive liquid seal - whilst substantially reducing the quantity of sealing fluid and the detrimental working load.

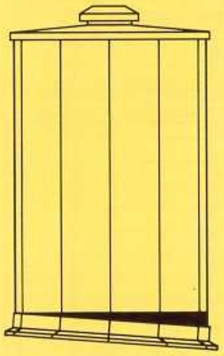
DESIGN PRINCIPLE:

In a polygonal hollow shell, stiffened at the upper end by the roof and at the lower end by the foundation, a sealing element - the piston - the position of which varies according to the content and which controls the pressure at the same time, floats on the gas.

The gasproof seal between the shell and the piston is effected by an ingenious device in conjunction with a fluid sealing medium (please refer to page 9).



THE FOLLOWING FEATURES ARE OF PARTICULAR INTEREST:

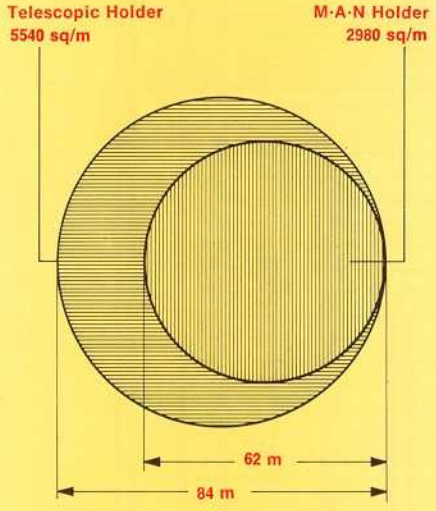


Abnormal soil subsidence at one side.

RE-LEVELLING POSSIBILITIES

In the case of vertical one-sided subsidence of the ground, re-levelling of the holder is possible by means of a relatively simple operation (bottom self-supported) if necessary without any shut-down. The holder is raised to the extent that the horizontal position is reached again by using jacks or hydraulic lifting devices arranged just in front of or under the columns.

To counter the effect of further possible subsidence, where unstable ground conditions exist, the holder, at the point where re-levelling has been necessary, may even be raised somewhat above the original level to provide for future yielding. The extent to which this may be desirable can be predicted with a high degree of accuracy.



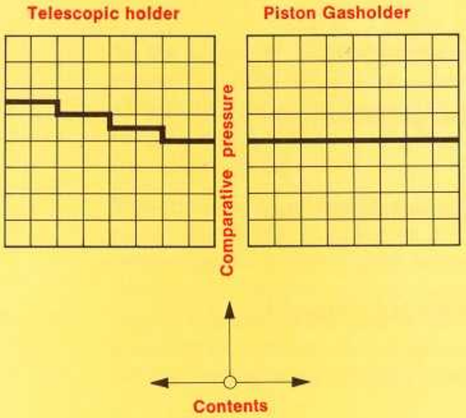
GROUND SPACE REQUIRED

The exclusive design principle of the piston type gasholder enables the holder to be more slenderly built than a telescopic gasholder. The smaller base area thus possible (example shown for size of 250,000 cu. m.) is an advantage in congested industrial areas where ground prices are high.

WORKING PRESSURE

The free movement of the piston which is not affected by weather conditions (snow, ice, gales) permits a virtually constant pressure throughout its travel. There is no major fluctuation of working pressure or pressure stages as may arise for example when uncupping and cupping the lifts of a telescopic gasholder.

Possible maximum working pressure approx. 850 mm w.g., measured at the piston.
Pressures over 850 mm w.g. are possible, have however to be discussed on a case to case basis.



FURTHERMORE

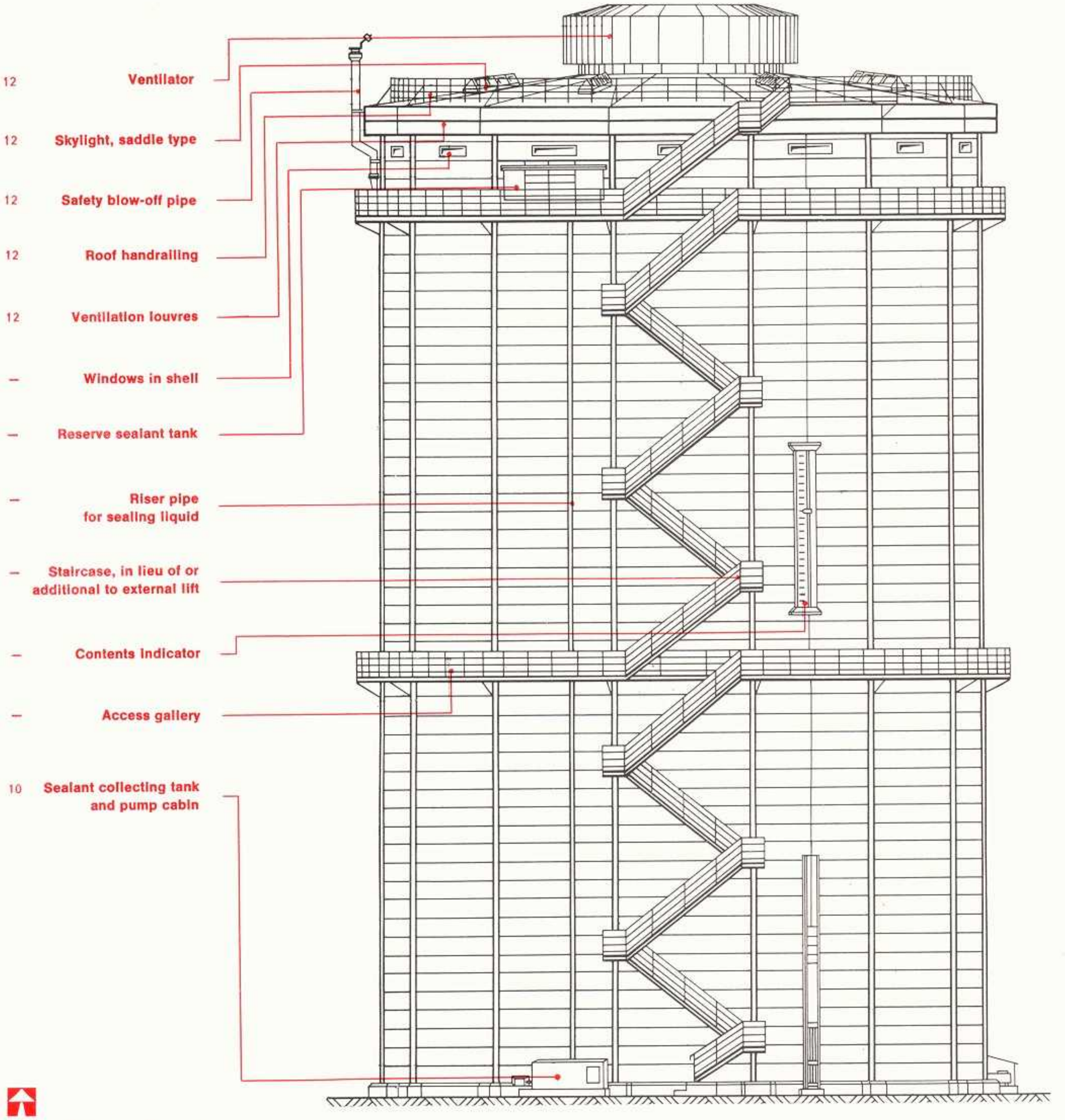
No hazard in starting up or shutting down, as the construction is practically without any "dead" space (see page 8).

Dry storage of gas, as no sealing water present.

Minimum heating expenditure; no heating required when storing dry gas.

Corrosion protection of the inner surface of the shell by the sealing fluid (see pages 10/11).

Painting same as for a normal steel structure.



Further details are given on these pages

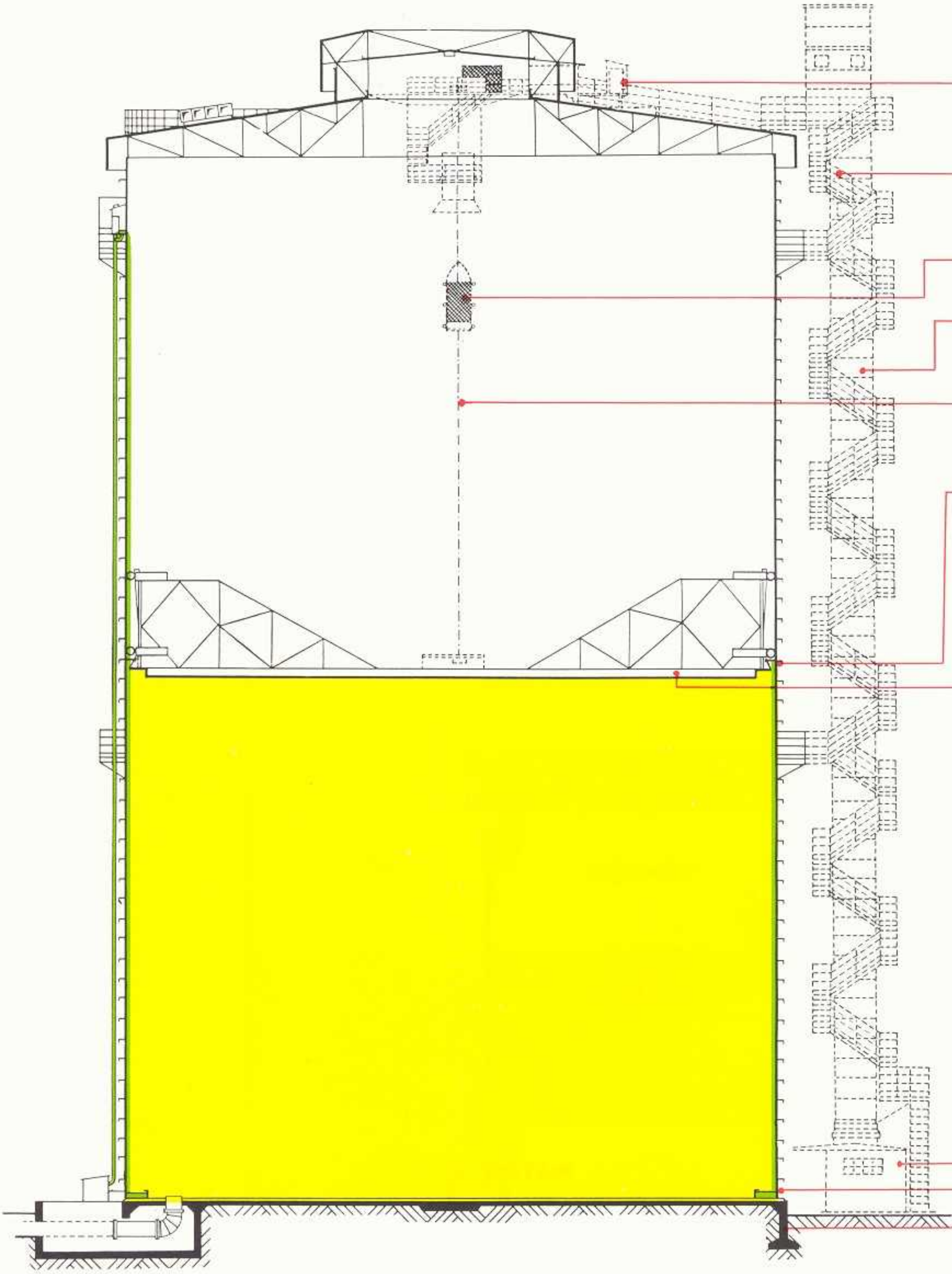
STRUCTURAL ELEMENTS

BOTTOM with bottom trough or sump and gas connections.

SHELL with galleries, staircases, shell windows, indicator and safety vent pipes.

ROOF with central ventilator, air inlets, saddle skylights and roof handrailing.

PISTON with piston-trough, seal, guide, rollers and tangential guides.

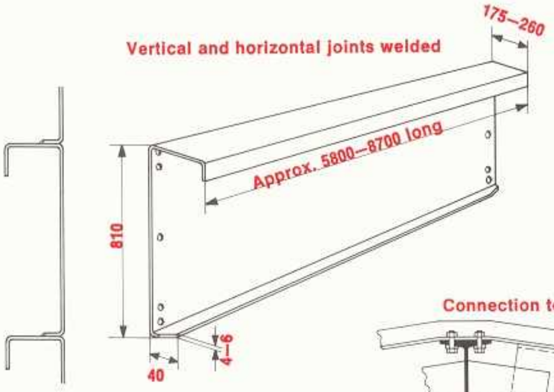


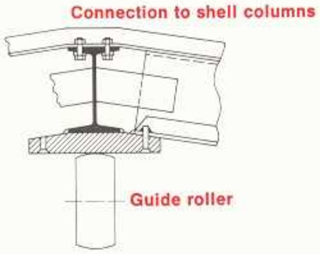
Further details are given on these pages

As the piston trough purposely loses a certain quantity of sealant, circulation of the sealant is necessary in piston trough, collecting tank, pumping set, riser pipes, overflow.

This circulatory system, the 'gasholder pulse' allows observations to be made (meters on the pumping sets) or readings transmitted to the control room to enable reliable conclusions to be formed about the condition of the piston seal without having to go onto the piston.

In the case of holders up to approx. 30,000 cu. m. capacity the outer stair-case is sufficient for access to the piston via the roof and usually, instead of the internal lift, a movable ladder suffices. For larger holders it is advisable to arrange an outer lift although this is not necessarily required. The stair-case is then led spirally around the lift shaft.





FLANGED PLATES

The plates used for roof, piston, gallery and shell (in some unstable subsoil mining areas the bottom plates also) consist of flanged open-hearth steel or equivalent, 3 - 6 mm thick (thickness depending on installation site and gas pressure). These plates are not only gas-tight and liquid-tight but, due to their special shape, can also be used at the same time for transmission of force.

SHELL

The use of flanged plates affords a special advantage in the shell as thus welding from the outside with a fillet seam is made possible. The vertical shell plate connections on the shell columns are arranged in the relatively sturdy face plates. Welded-in fitting bolts for the force transmission and the vertical weld seam as sealing element ensure a proper connection.

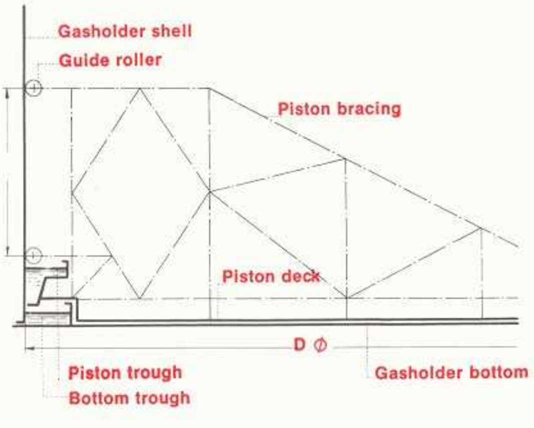
Using the advantages derived from this form of construction and in order to provide clear statical conditions, the round cross section customary for telescopic gasholders was abandoned and the polygonal structure with 6 to 26 corners was introduced.

PISTON

As the piston is designed without dead space, the accumulation of any substantial explosive gas-air mixture during starting-up or shutting-down is practically impossible. Furthermore, this design offers effective protection against damage due to low pressure.

The piston is guided vertically by two rings of rollers located in a vertical spacing of approx. 1/10 of the holder diameter at the piston assembly.

The rollers run on the column guide bars, i. e. on fixed rails which are held firmly by the polygonal construction of the holder shell. Horizontal rotation of the piston is prevented by 2 tangential guides movable in radial direction. With this type of piston guide, the differences in pressure arising during the change of the piston movement are only a few mm w. g. Normally the construction weight of the piston does not suffice for the adjustment of the required gas pressure. Therefore, concrete weights have to be evenly distributed on the piston deck (see illustration).



PISTON SEAL

The flexible steel slide strips, suspended on the inner wall of the piston trough to allow slight flexibility, are pressed against the holder shell by numerous contact elements. The flexible joint between guide bars and piston consists of a specially woven fabric of a tough and sufficiently impermeable texture which is not adversely affected by the sealing liquid. The wooden fender prevents possible damage of the main sealing fabric which could otherwise result in unforeseen friction of fabric and steel.

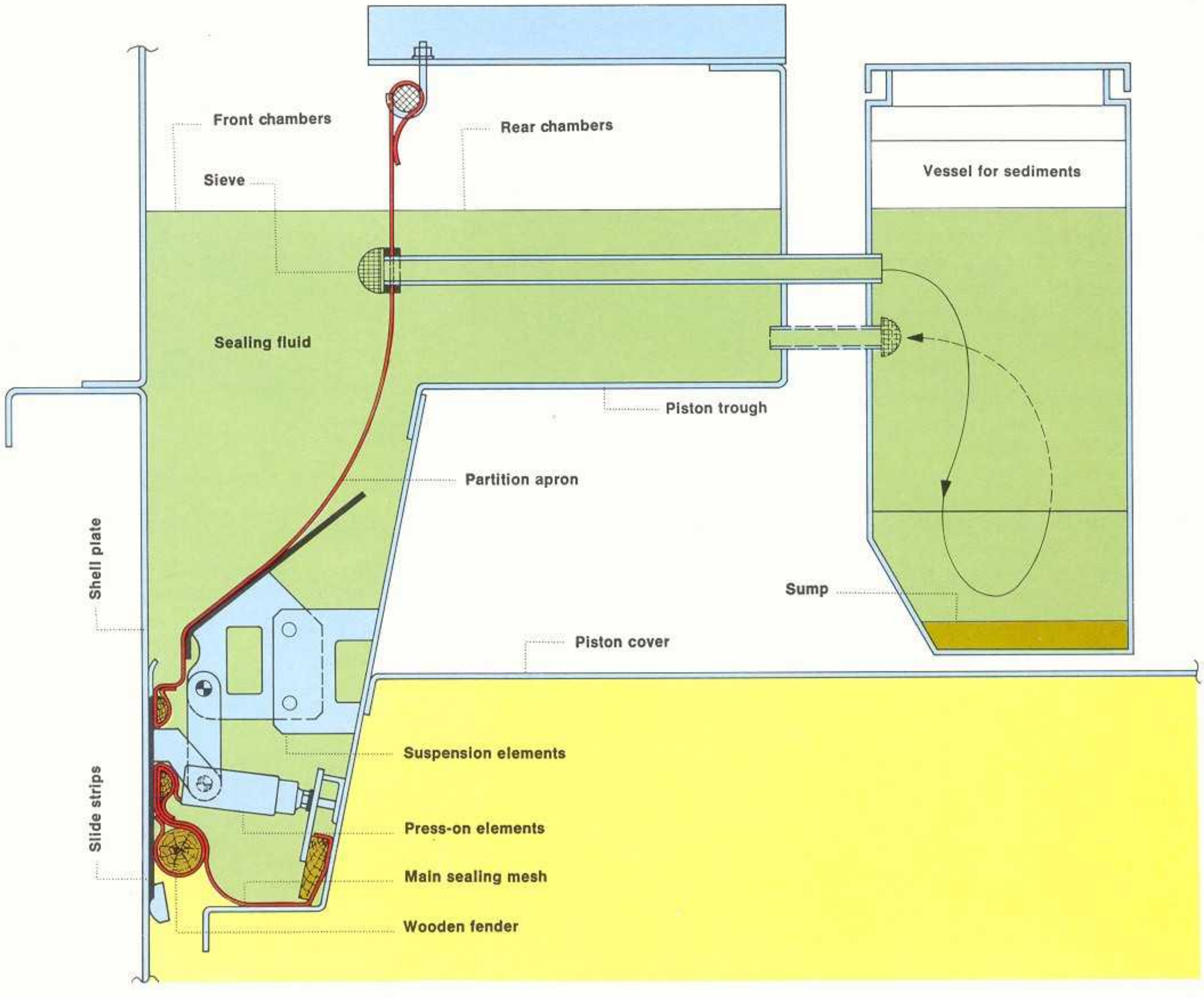
The piston trough is filled with a sealing fluid to ensure a positive gas seal, for which purpose, usually, a tar or mineral oil with a low setting point and good water separation properties is chosen, suitable for the type of gas in the gasholder. This sealing fluid runs in a thin film slowly along the holder shell and thus forms, at the same time, an extremely durable corrosion protection against the aggressive components of the gas (please compare illustration on page 11).

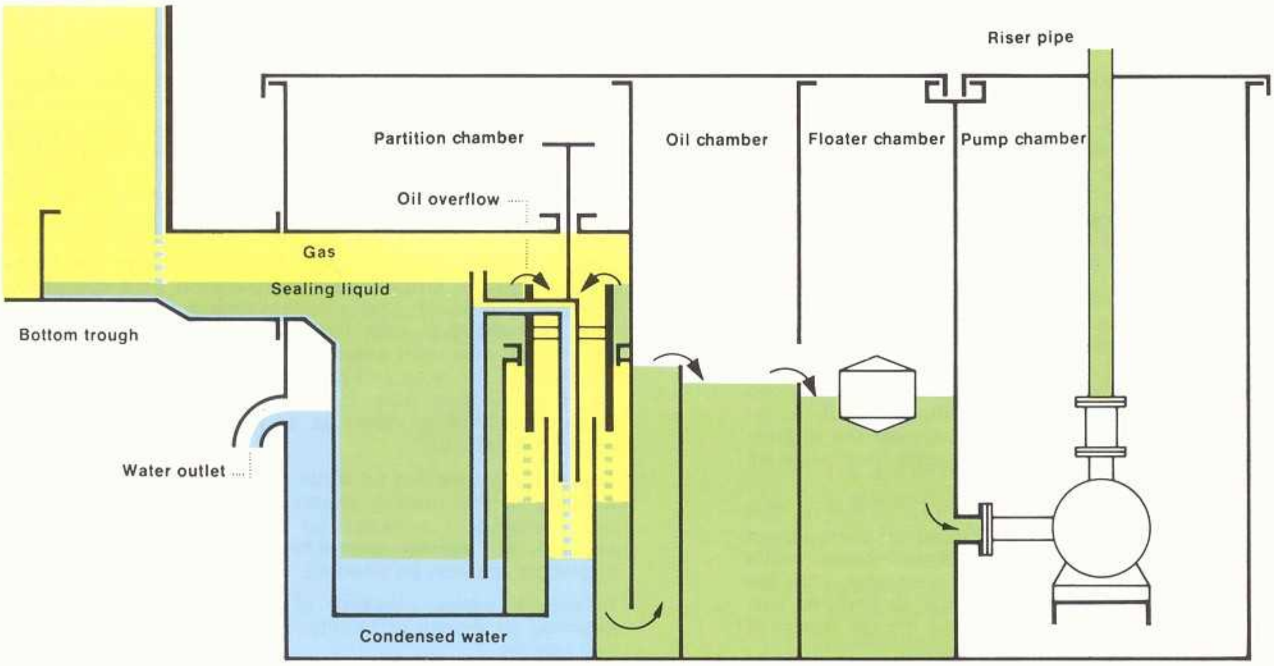
Of even greater importance is the function of the oil film during winter operation. The rime formed at low ambient temperatures from condensed water vapour cannot settle directly on the holder shell and slowly become a thick ice layer because of the oil intermediate layer. It finds no surface contact and drops into the heated trough where it melts and drains off to the outside as water.

This action is mechanically supported by the razor-edged, slanting edges of the slide strips. A solid ice deposit on the holder wall is thus impossible. In the case of a sealing liquid with a specific gravity below 1, the condensation water forming on the shell of the piston space would drop immediately in the oil in the piston trough. In the front chamber formed by the partition apron, the large water drops are led below between the slide strips and shell directly into the bottom trough. Any small suspended drops or any possible suspended contamination from the piston space will be led off after a certain time or will deposit resp. The rear chamber with the press-on elements is, in all cases, kept free from water and contamination. To equalize the fluids in the front and rear chamber, a vessel connected via a connecting pipe is arranged in which water and contamination drop down as only very little liquid movement takes place.

The above shows that no water can collect in the seal. Thus, freezing of the moving elements during winter operation and consequent endangering of the sealing function is avoided. All sealing elements remain accessible during operation and can be checked.

In special cases, pressure of the sealing strips can be adjusted by means of counter-weight levers or by springs and sleeves.





SEALANT CIRCUIT

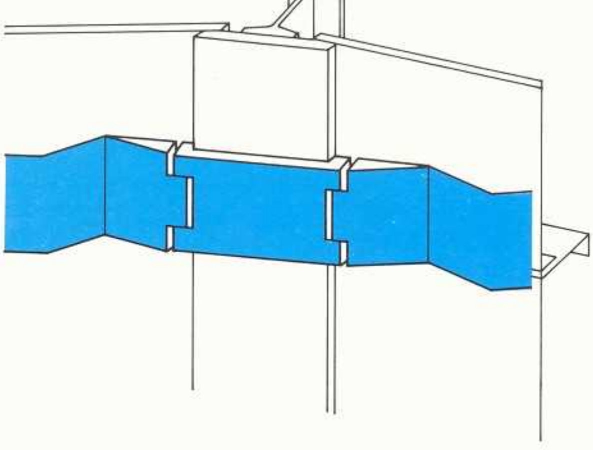
The sealing liquid flowing down the holder shell is collected, together with any condensate, in the bottom sump which is heated in winter where the two fluids segregate due to the difference in specific gravities and the water separation properties of the sealant itself.

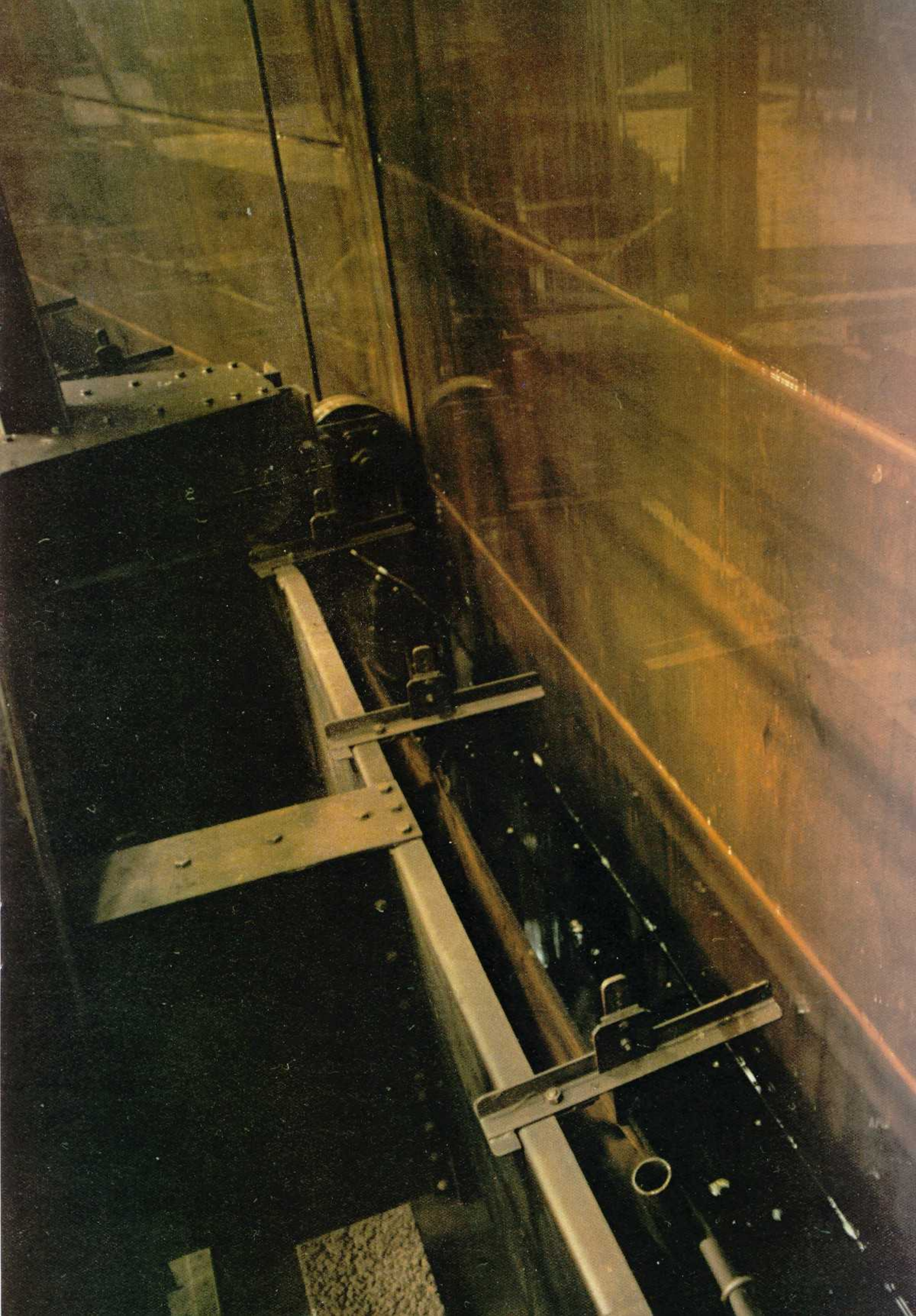
The fluids flow to the 1 – 6 collecting tanks (according to the circumference of the gas holder) in which on the one hand outlet of the condensate is effected and on the other hand feeding of the sealing liquid, free of water, into the circuit is effected by means of appropriate devices.

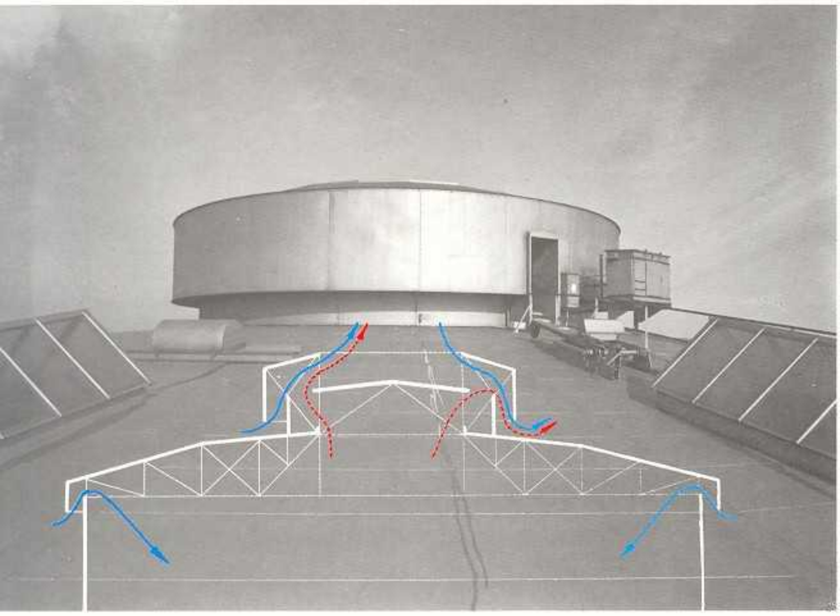
Small pumps working intermittently and switching on and off, controlled by a float, convey the sealing fluid to the overflows on the upper shell edge through riser pipes from where the fluid flows back into the piston trough. These overflows are combined with spare vessels which contain such a sufficiently measured quantity of sealing liquid not included in the circuit that in the event of any possible power failure, the gasholder will be supplied from same for a longer period and thus, can be kept operating.

Piston construction (Inside view)

Sealing of the guide bars

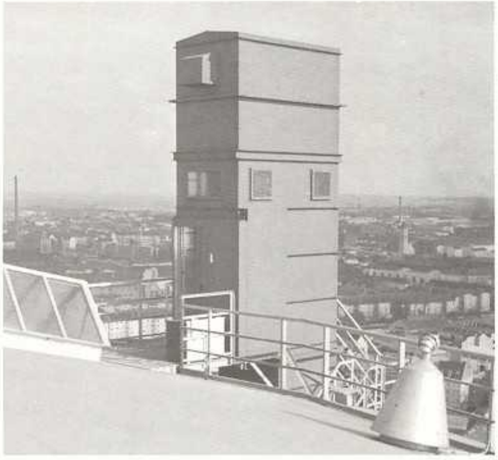






VENTILATION

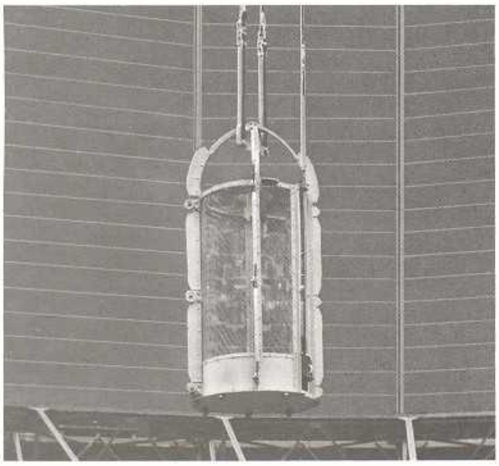
The large ventilation openings provided at the top of the shell all around the circumference and the large ventilator arranged in the centre of the roof effect constant and adequate ventilation of the space above the piston because of their special shape and the constant air movement prevailing at roof height. All ventilation openings are provided with suitable covers and protective sheet metal plates to prevent the ingress of snow or driving rain.



The illustration above shows the ventilator on the roof with access to the internal lift and winch. The photograph on the left-hand side shows the upper station of the external lift as well as two of the saddle sky-lights which together with the windows in the upper shell section provide excellent brightening of the space above the piston (please refer to photo on page 3).

SAFETY BLOW-OFF PIPES

At the upper shell edge safety blow-off pipes are arranged which prevent an increase of pressure in the gas space when the upper piston limit is reached.



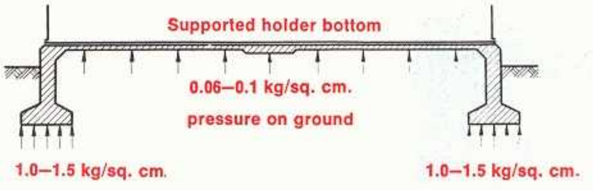
INTERNAL LIFT

Although the recorded number of pump runs provides a reliable ground-level indication as to the satisfactory operation of the seal, without having to perform a test run of the gas holder, internal inspection should be carried out periodically and routine inspections are prescribed in the operating instructions. The piston may be reached conveniently and quickly by an internal electric lift.
The left-hand illustration shows the lift cage.

FOUNDATIONS

STANDARD FOUNDATION

In areas where subsoil stability presents no problem, the gasholder is normally erected upon an annular foundation of relatively light reinforced concrete construction, supporting a bottom slab of only approx. 100-120 mm thickness. In special cases, the slab may in fact be dispensed with. The pressure on the soil under the ring base is approx. 1.0-1.5 kg/sq. cm. and below the bottom plate only approx. 0.06-0.1 kg/sq. cm. If necessary, the side walls of the ring foundation can be raised thus providing a storage space the basic area of which is more or less identical to the corresponding gas holder. As an example, a waterless holder of 100,000 cu. m. capacity would provide effective storage space below to the extent of approx. 1500 sq. m. which is considerably lower in costs than a corresponding separate building.

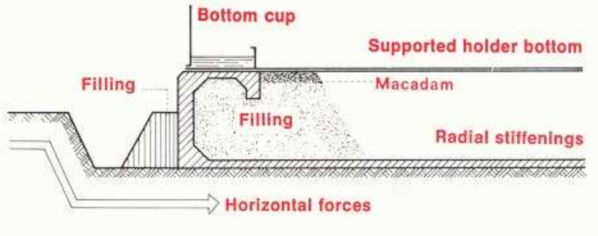


FOUNDATION SUBSOIL

If there are horizontal ground stresses caused by mining subsidence for example, the normal foundation would be damaged by the arising, very high, uncontrollable forces. Therefore, special mining subsidence foundations were developed for the piston gasholders whereby one- sided subsidence of the ground and thus also of the holder can be compensated by raising the holder - if necessary during operation - to its original horizontal position, within a few hours, by means of hydraulic jacks.

Light mining damage

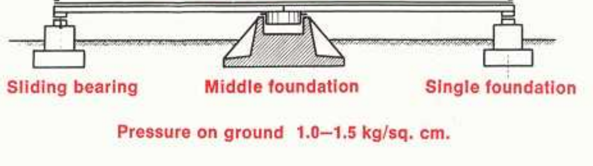
The foundation is shaped as a trough. Arising horizontal forces could only have effect at the supporting plane of the trough due to the special shape of ground where they would not encounter any important attacking points and thus would not cause any destruction. For practical reasons a sliding layer (sand) is provided under the trough. The decision as to whether the trough foundation described below will have to be used can only be made after careful examination of the sub-soil conditions.

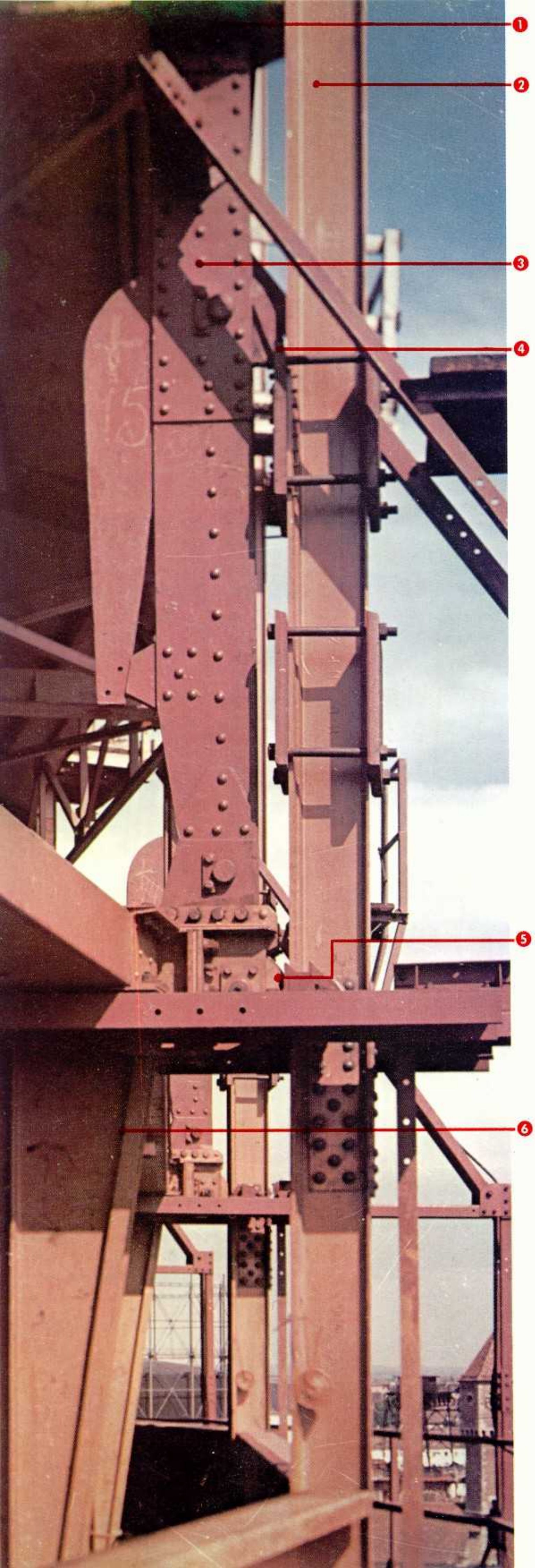


Heavy mining damage

Below every corner holder point an individual foundation is arranged; in the center of the self-supporting holder floor there is a middle foundation. The latter should absorb a large part of the wind force, the remaining part is compensated by the friction between pedestals and corner foundations.

The product of highest pedestal pressure x sliding factor of bearing - mostly on steel determines the max. horizontal force for the calculation of the holder floor. In the event that tension or compression forces exceed this value, the individual foundations can move horizontally, without exceeding the permissible tensions in the holder floor.

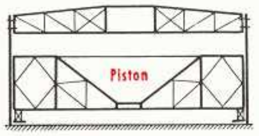




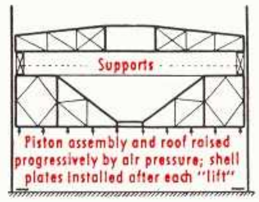
ERECTION

The erection procedure is remarkable in its simplicity and logic. The following 4 main operations are characteristic for the construction of the piston gasholder:

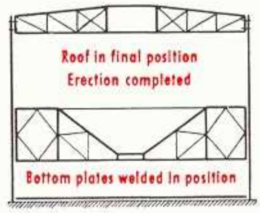
The lower uprights with their anchorages are placed in position and braced by several shell plate courses. This is followed by the assembly of the roof structure, then the roof plates are laid and welded, as well as the vents and roof railing.



Below this section the marginal bottom plates are laid, then the piston structure with piston roof, sealing trough and guides for erection. Thereupon the roof is lowered onto the piston construction by means of special supports (please refer to the adjacent photo).



The piston and roof are then progressively raised by air pressure and at the same time the erection of the shell, stairs and galleries is carried out. The piston does not only serve in this case as erection platform, but also as cross-sectional lay-out gauge using a system of guide rollers.



In the final position the roof is finally connected to the shell after completing the welding of the bottom inside area. The piston is then lowered and the holder is ready for the leakage test.

1. **Roofing**
2. **Shell columns**
3. **Support between piston and roof**
4. **Suspension on shell columns**
5. **Guide roller system**
6. **Piston**

Gasholder during erection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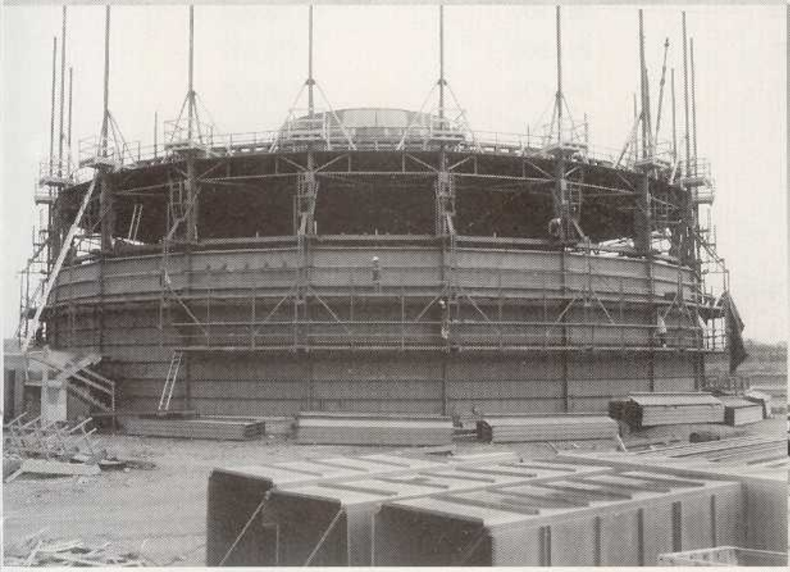
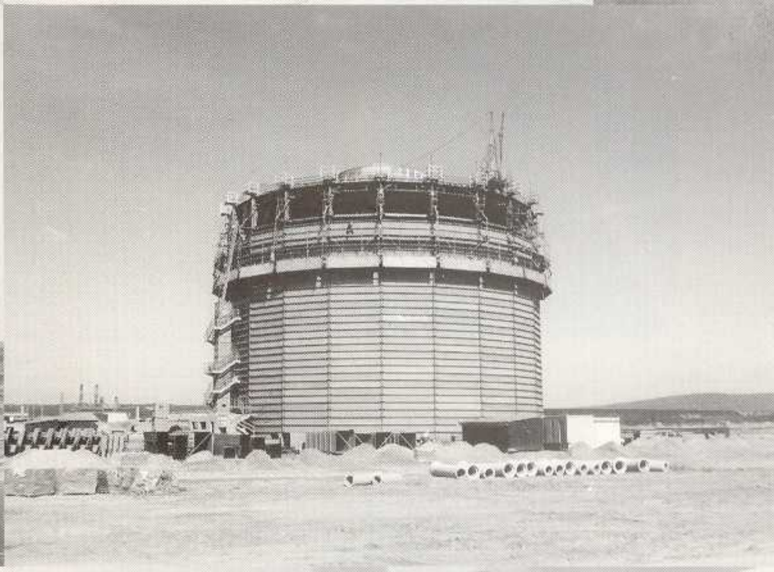
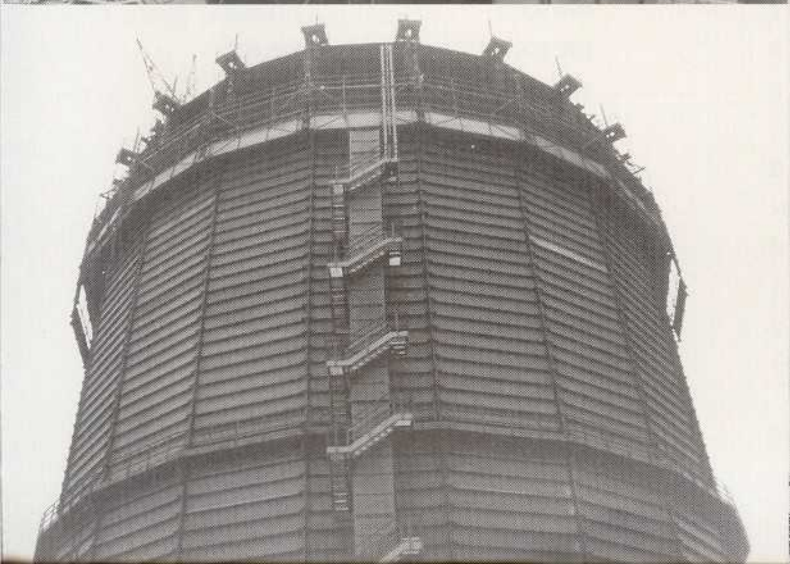
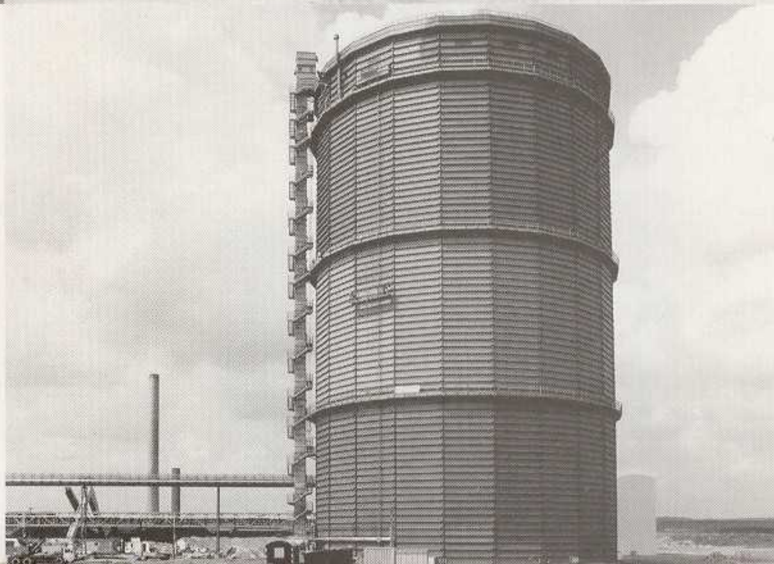








MAINTENANCE SERVICING

After completed erection, the leakage test will be carried out and the gasholder will be subjected to inspection and will then be passed to the care of the client. After a guarantee period, normally limited to one year, the holder will be surveyed on the request and order of the client.

This also includes the checks of oil samples submitted with regard to their further utilization with findings and possible practical advice when necessary.
Furthermore, we effect world-wide reparations and modernisations on existing gasholders.

LISTING

of Piston Gasholder fabricated by LEFFER

Year of construction	Country	Plant	Capacity (cu. m.)
1984	Germany	Z.K.S. Dillingen	77 000
1986	Brasil	Confab	40 000
1987	Spain	Aviles	60 000
1987	Germany	Thyssen Duisburg	100 000
1988	China	Benxi	165 000
1996/1997	Korea	HanBo Steel	60 000

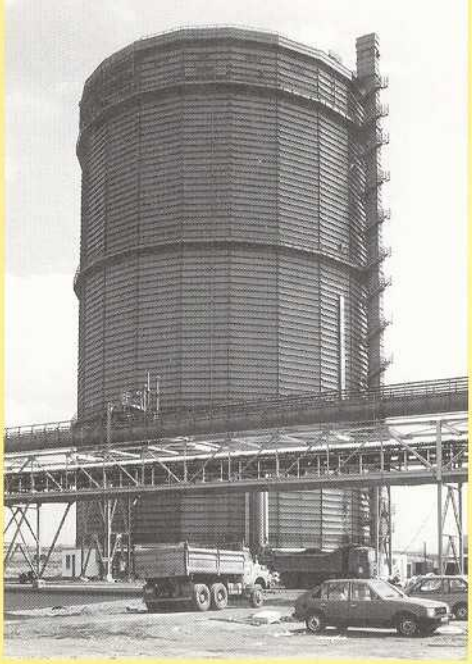
LIST OF PISTON-TYPE GASHOLDERS

supplied and erected by MAN and their licensees and ordered from them until 1980.

Country	Number	Total capacity cu. m.	Largest holder cu. m.
Germany	153	9 253 200	350 000
Belgium	9	255 000	50 000
Denmark	6	250 500	100 000
England/Ireland	65	4 149 400	226 400
France	21	564 500	85 000
Holland	21	1 201 000	175 000
Italy	15	567 000	100 000
Jugoslavia	1	30 000	30 000
Austria	7	1 090 000	300 000
Poland	6	195 500	70 000
Russia	1	100 000	100 000
Sweden	3	305 000	200 000
Switzerland	4	110 000	50 000
Spain	15	643 000	100 000
Turkey	2	42 000	28 300
Czechoslovakia	5	445 000	150 000
Africa	4	169 800	56 600
Argentina	5	355 000	150 000
Australia	7	498 000	141 500
Brazil	8	292 500	125 000
Chile	2	165 000	120 000
Cuba	1	70 000	70 000
India	8	624 500	155 600
Japan	24	2 990 700	300 000
Manchuria	2	260 000	180 000
Peru	1	20 000	20 000
Singapore	2	84 900	56 600
USA and Canada	81	14 078 700	566 000
	479	38 810 700	

LEFFER GASHOLDER TYPE M.A.N

approx. 77 000 cu. m. capacity
at Z.K.S. Dillingen/Germany
Year of construction 1984

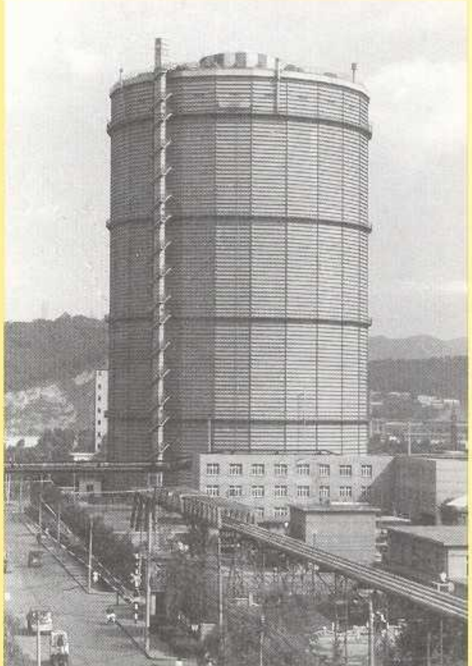


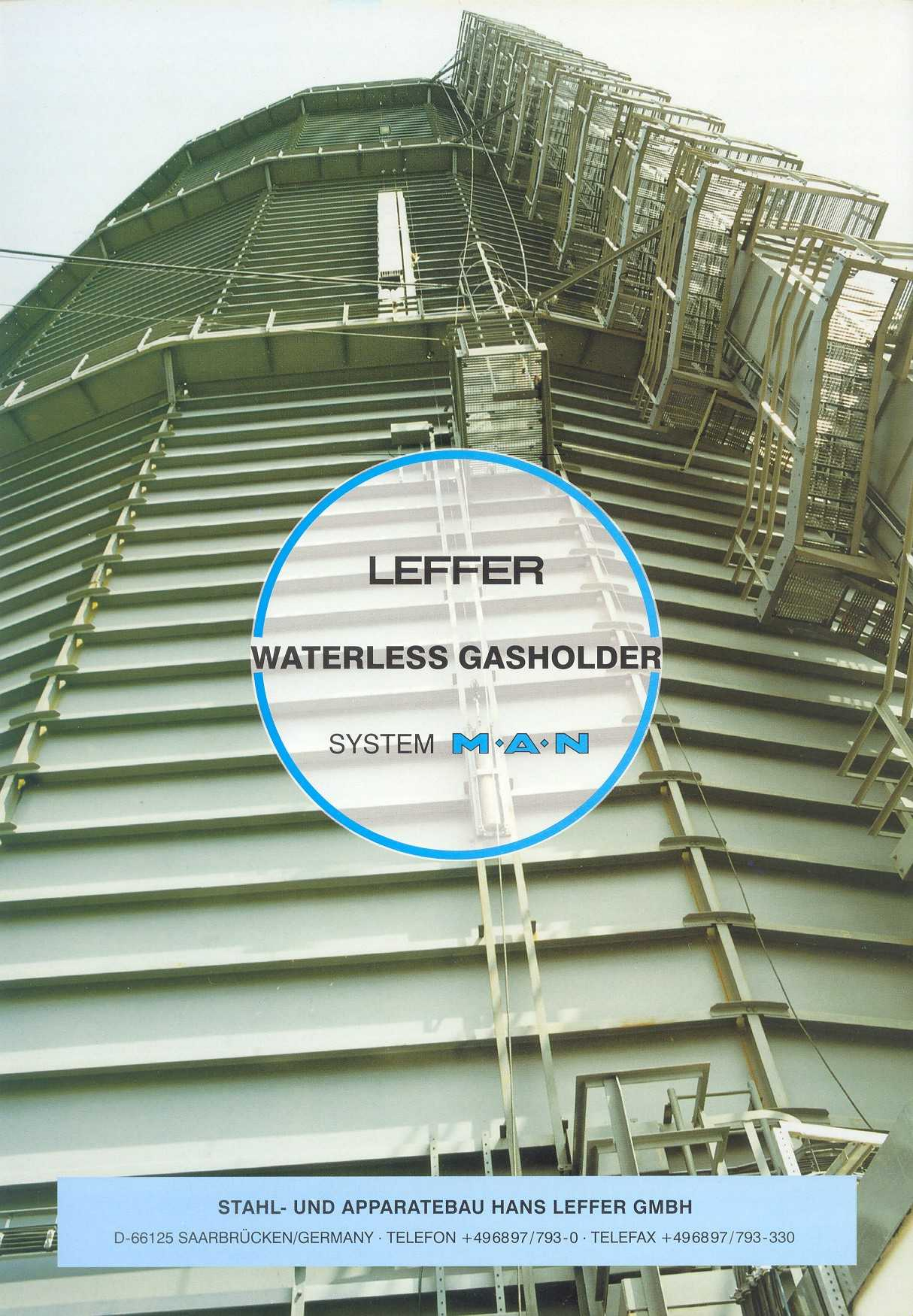
LEFFER GASHOLDER TYPE M.A.N

approx. 100 000 cu. m. capacity
at Thyssen Stahl Duisburg/Germany
Year of construction 1987

LEFFER GASHOLDER TYPE M.A.N

approx. 165 000 cu. m. capacity
at Benxi / China
Year of construction 1988





LEFFER

WATERLESS GASHOLDER

SYSTEM M·A·N

STAHL- UND APPARATEBAU HANS LEFFER GMBH

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PISTON TYPE GASHOLDERS **Status March 2012**

Year	Customer and Plant	Subject	Type of Gas	Pressure (mm WC)
1984	Z K S Dillingen / Germany	77.000 m^3	COG	600
1986	CONFAB / Brasilia (Engineering, partial supply and Supervising of Erection)	40.000 m^3	COG	550
1986	BENXI / China (Engineering, partial supply and Supervising of Erection)	165.000 m^3	COG	850
1987	THYSSEN Beeckerwerth / Germany	100.000 m^3	LD	140
1987	GIJON VERINAR II / Spain (Engineering, partial supply and Supervising of Erection)	80.000 m^3	COG	600
1996	HANBO Steel / Korea (Engineering, partial supply and Supervising of Erection)	60.000 m^3	COREX	600
1997	CSI-Planos Aboño / Spain (Engineering, partial supply and Supervising of Erection)	120.000 m^3	BF	650
1998	CSI-Planos Veriña II / Spain (Engineering, partial supply and Supervising of Erection)	80.000 m^3	COG	600
2000	STEWEAG / Austria (Engineering, partial supply and Supervising of Erection)	15.000 m^3	LD	180

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Rechtsform: KG, Sitz Saarbrücken, Registergericht Saarbrücken HRA 9978
Komplementärin: Leffer Engineering GmbH, Sitz Saarbrücken, Registergericht Saarbrücken HRB 17856
Geschäftsführer: Hans Georg Leffer, Georg Konrad Leffer

PISTON TYPE GASHOLDERS **Status March 2012**

Year	Customer and Plant	Subject	Type of Gas	Pressure (mm WC)
2003	THYSSEN KRUPP STAHL Duisburg / Germany	90.000 m^3	BF	800
2003	EKO Stahl Eisenhüttenstadt / Germany	90.000 m^3	LD	180
2006	POSCO POHANG Works / Korea	90.000 m^3	FINEX	900
2006	ARCELOR MITTAL Sidmar / Belgium	50.000 m^3	COG	800
2006	SAARSTAHL Germany	120.000 m^3	LD	200
2007	ARCELOR MITTAL Sidmar / Belgium	90.000 m^3	LD	200
2007	SALZGITTER Flachstahl GmbH / Germany	140.000 m^3	BF	550
2007	SALZGITTER Flachstahl GmbH / Germany	70.000 m^3	LD	250
2007	SAMSUNG / HYUNDAI Steel Plant / Korea	200.000 m^3	BF	800
2007	SAMSUNG / HYUNDAI Steel Plant / Korea	70.000 m^3	COG	400
2008	ARCELOR MITTAL Bremen / Germany	90.000 m^3	LD	200
2008	POSCO GWANGYANG Works / Korea	70.000 m^3	COG	470
2009	VOESTALPINESTAHL LINZ	90.000 m^3	LD	150
2011	SAMSUNG / HYUNDAI Steel Plant / Korea *under construction*	150.000 m^3	BF	730
2011	SAMSUNG / HYUNDAI Steel Plant / Korea *under construction*	70.000 m^3	COG	350

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UID/VAT ID No.: DE 814736552

PISTON TYPE GASHOLDERS **Status March 2012**

Year	Customer and Plant	Subject	Type of Gas	Pressure (mm WC)
2011	POSCO GWANGYANG Works / Korea *under construction*	150.000 m³	BF	890
2011	POSCO KRAKATAU / Indonesia *under construction*	80.000 m³	BF	700
2011	POSCO KRAKATAU / Indonesia *under construction*	40.000 m³	COG	400
2011	POSCO POHANG Works / Korea *under construction*	100.000 m³	FINEX	890
2012	POSCO EC PECEM / Brazil *under construction*	80.000 m³	BF	700
2012	POSCO EC PECEM / Brazil *under construction*	40.000 m³	COG	480

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