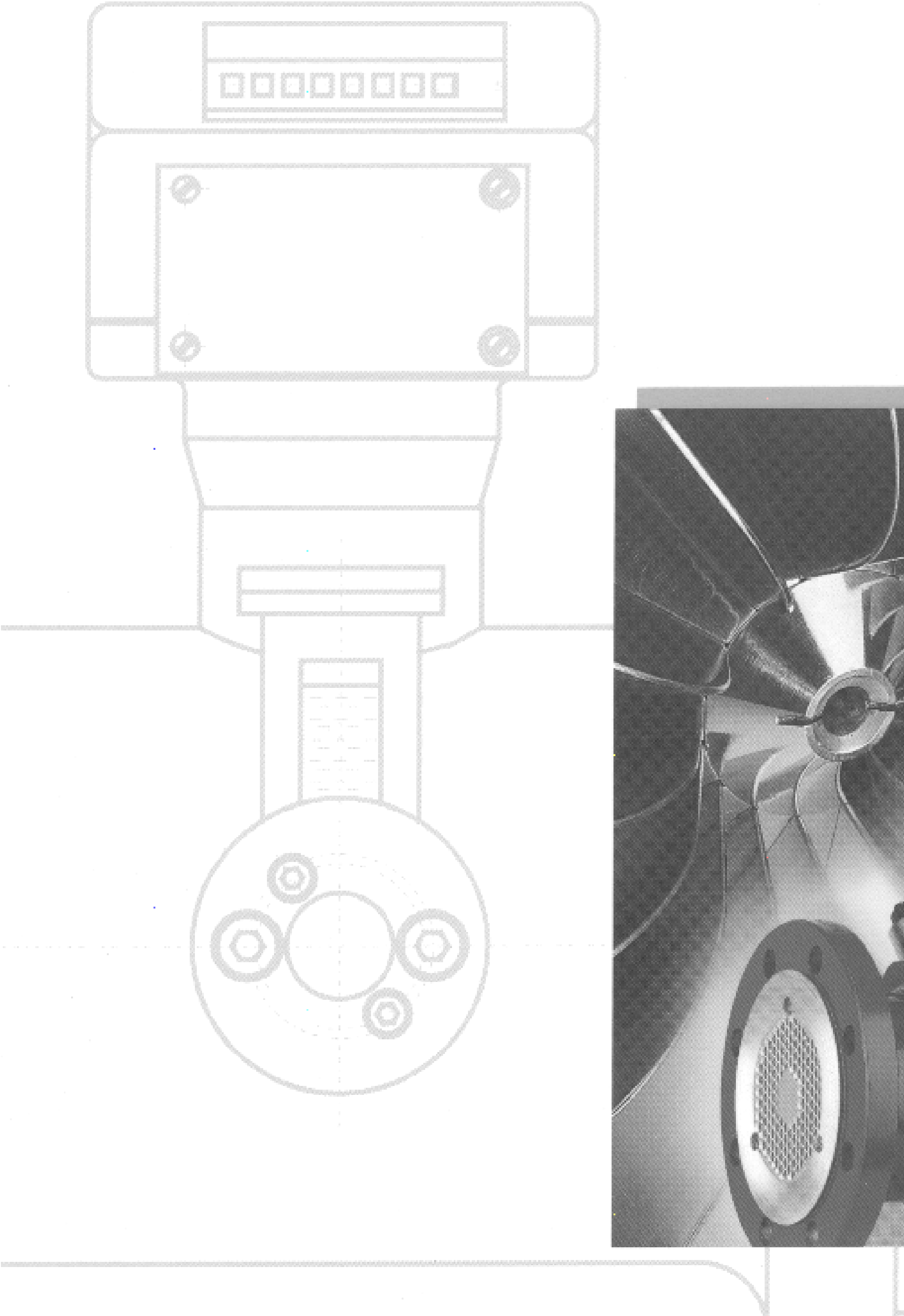
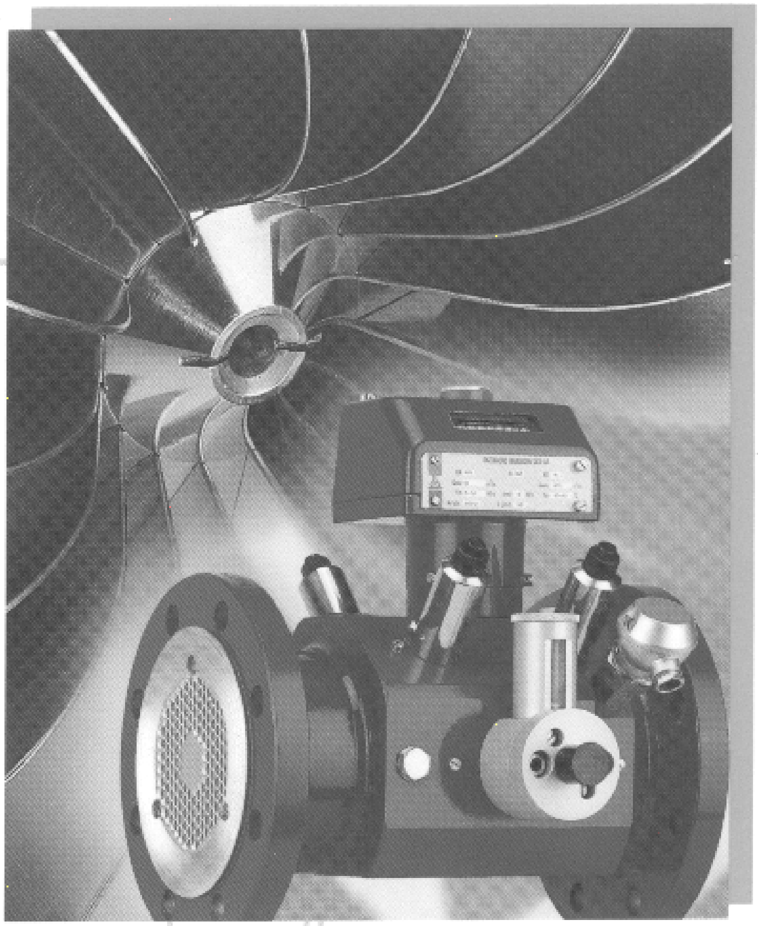
COMMON





TURBINE GAS METER

Manual

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1. Design and Function

1.1. Description

The turbine gas meters CGT serve for the volume measurement of flowing gases. They were developed by the company COMMON in close co-operation with the oil and gas industry. The standard version is appropriate for the gases in table 1 for pressure rates up to 100 bar. The operating pressure amounts to thus 0 to p_{max} the appropriate pressure rate of the meter.

Table 1. List of appropriate gases for the measurement with turbine gas metes in standard version

Gas	Symbol (chemical formula)	Density ρ_n* [kg/m³]	Density relating to air
Argon	Ar	1,78	1,38
Ethylene	C_2H_4	1,26	0,98
Butan	C_4H_{10}	2,71	2,09
Ethan	C_2H_6	1,36	1,06
Natural gas	-	~0,83	~0,64
Helium	He	0,18	0,14
Carbon dioxide	CO_2	1,97	1,53
Carbon monoxide	CO	1,25	0,97
Air	-	1,29	1,00
Methan	CH_4	0,72	0,55
Propane	C_3H_8	2,01	1,56
Nitrogen	N_2	1,25	0,97
Hydrogen	H_2	0,09	0,07

*(ρ_n at 1,01325 bar and 273,15 K)

The gas meters are specified by the following parameters:
Nominal size DN, maximal operating pressure p_{max}, as well as maximum flow Q_{max} and minimum flow Q_{min} under operating pressure and operating temperature.
The admissible error between Q_{max} and Q_{min} under operating conditions is determined by the margins of error of turbine gas meters.
The minimum flow results from the pattern approval.

1.2. Function

The measurement principle of the turbine gas meter is based on the proportionality of the linear gas rate for the rotating speed of the turbine wheel in the defined annular space of the measuring cartridge. This area of the gas meter was designed according to the laws of the mechanical measuring technique of liquids and gases. Counter sums up the passed gas volume and brings it to the display.

1.3. Meter sizes

The standard sizes of the COMMON turbine gas meters are arranged in table 2. On request also the supply of larger nominal sizes is possible.

Table 2. Standard sizes of the turbine gas meters CGT

DN		G-Size	maximum flow Q_{max}	minimum flow Q_{min}	Measure ment range	LF1 – LF4 Counter head pulse rate - U_a m^3/Imp.	HF1 – HF2 Counter head m^3/Imp.	HF3 – HF6 Turbine- and Reference wheel m^3/Imp.
mm	inch		[m^3/h]	[m^3/h]				
50	2	40	65	6	1:10	0,1	1,84929E-04	6,10862E-06
		65	100	10			3,69858E-04	1,01810E-05
80	3	100	160	8	1:20	1	9,24645E-04	2,34947E-05
		160	250	13			1,18519E-03	3,26246E-05
		250	400	20			2,12954E-03	5,86196E-05
100	4	160	250	13	1:20	1	7,22932E-04	3,40498E-05
		250	400	20			1,44586E-03	5,95871E-05
		400	650	32			2,58587E-03	1,06569E-04
150	6	400	650	32	1:20	1	2,58587E-03	1,06569E-04
		650	1000	50			4,57365E-03	1,50792E-04
		1000	1600	80		10	7,75761E-03	2,55766E-04
200	8	650	1000	50	1:20	1	8,61957E-03	2,84185E-04
		1000	1600	80		10	8,61957E-03	2,84185E-04
		1600	2500	130			1,44586E-02	4,76697E-04
250	10	1000	1600	80	1:20	10	1,72391E-02	4,73641E-04
		1600	2500	130			1,72391E-02	4,73641E-04
		2500	4000	200			2,97619E-02	8,17701E-04
300	12	1600	2500	130	1:20	10	3,08315E-02	8,47089E-04
		2500	4000	200			3,08315E-02	8,47089E-04
		4000	6500	320			5,35645E-02	1,47167E-03

1.4. Dimensions

The external dimensions of the turbine gas meters can you take from the table 3. An allocation of the parameters takes place according to the figure 1. The dimensions are to be considered when planning from measuring systems.

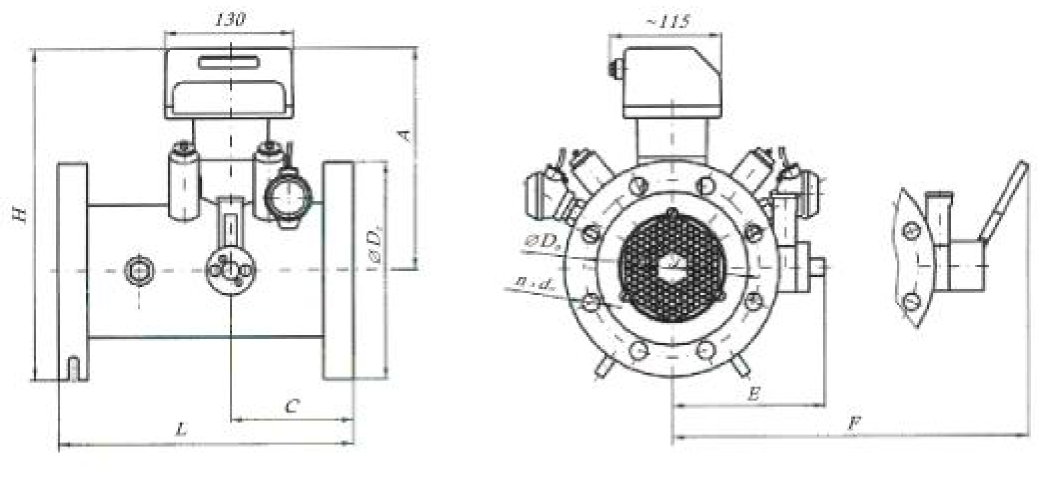


figure 1: External dimensions of the turbine gas meter CGT

Table 3. Dimensions and weights of the turbine gas meter CGT (part 1).

DN	Pressure rate	G*	L	H	A	C	E	F	D_z	D_0	d_0	n	Weight
mm			mm	mm	mm	mm	mm	mm	mm	mm	mm		kg
	PN10/16	g		286	203		150	-	165	125	18	4	8
	PN10/16	f		286	203		150	-	165	125	18	4	9
	PN25/40	f		286	203		-	226	165	125	18	4	10
50	PN63	f	150	294	203	92	-	226	180	135	22	4	12
	ANSI150	g		280	203		150	-	152,4	120,7	19,1	4	8
	ANSI150	f		280	203		150	-	152,4	120,7	19,1	4	9
	ANSI300/600	f		286	203		-	226	165,1	127	19,1	8	17
	PN10/16	g		315	215		146	-	200	160	18	8	18
	PN10/16	f		301	206		146	-	200	160	18	8	19
	PN25/40	f		301	206		-	222	200	160	18	8	23
80	PN63	f	240	306	206	145	-	222	215	170	22	8	26
	ANSI150	g		311	215		146	-	190,5	152,4	19,1	4	19
	ANSI150	f		297	206		146	-	190,5	152,4	19,1	4	20
	ANSI300/600	f		302	206		-	222	209,6	168,1	22,4	8	29
	PN10/16	g		340	229		157	-	220	180	18	8	23
	PN10/16	f		320	220		157	-	220	180	18	8	24
	PN25/40	f		332	220		-	233	235	190	22	8	30
	PN63	f		338	220		-	233	250	200	26	8	40
100	ANSI150	g	300	345	229	176	157	-	228,6	190,5	19,1	8	24
	ANSI150	f		329	220		157	-	228,6	190,5	19,1	8	25
	ANSI300	f		336	220		-	233	254	200,2	22,4	8	42
	ANSI600	f		347	220		-	233	273,1	215,9	25,4	8	52
	PN10/16	g,s		400	256		185	-	285	240	22	8	47
	PN10/16	f		377	247		185	-	285	240	22	8	65
	PN25/40	s		407	256		-	264	300	250	26	8	60
	PN25/40	f		390	247		-	261	300	250	26	8	67
	PN63	s		430	256		-	264	345	280	33	8	72
	PN63	f		409	247		-	261	345	280	33	8	80
150	ANSI150	g,s	450	397	256	270	185	-	279,4	241,3	22,4	8	48
	ANSI150	f		380	247		185	-	279,4	241,3	22,4	8	50
	ANSI300	s		416	256		-	264	317,5	269,7	22,4	12	75
	ANSI300	f		398	247		-	261	317,5	269,7	22,4	12	85
	ANSI600	s		435	256		-	270	355,6	292,1	28,4	12	105
	ANSI600	f		412	247		-	261	355,6	292,1	28,4	12	115
	PN10	g,s		441	270		202	-	340	295	22	8	70
	PN10	f		432	261		202	-	340	295	22	8	75
	PN16	g,s		441	270		202	-	340	295	22	12	70
	PN16	f		432	261		202	-	340	295	22	12	75
	PN25	s		451	270		-	278	360	310	26	12	80
	PN25	f		442	261		-	278	360	310	26	12	90
	PN40	s		459	270		-	282	375	320	29,5	12	95
	PN40	f		450	261		-	278	375	320	29,5	12	105
200	PN63	s	600	479	270	360	-	282	415	345	36	12	120
	PN63	f		470	261		-	278	415	345	36	12	130
	ANSI150	g,s		443	270		202	-	342,9	298,5	22,4	8	70
	ANSI150	f		434	261		202	-	342,9	298,5	22,4	8	80
	ANSI300	s		462	270		-	282	381	330,2	25,4	12	125
	ANSI300	f		453	261		-	278	381	330,2	25,4	12	135
	ANSI600	s		481	270		-	282	419,1	349,3	31,8	12	160
	ANSI600	f		472	261		-	278	419,1	349,3	31,8	12	175

* (G → housing versions: g - from cast irons; s - from steel with welded connecting pieces; f - from steel turned)

Table 3. Dimensions and weights of the turbine gas meter CGT (part 2)

DN mm	Pressure rate	G*	L mm	H mm	A mm	C mm	E mm	F mm	D_z mm	D_0 mm	d_0 mm	n	Weight kg
	PN10	s		497	298		232	-	395	350	22	12	125
	PN16	s		502	298		232	-	405	355	26	12	130
	PN25	s		512	298		-	308	425	370	29,5	12	150
250	PN40	s	750	524	298	420	-	308	450	385	32,5	12	170
	PN63	s		534	298		-	308	470	400	36	12	195
	ANSI150	s		503	298		232	-	406,4	362	25,4	12	140
	ANSI300	s		522	298		-	308	444,5	387,4	28,4	16	200
	ANSI600	s		553	298		-	308	508	431,8	35,1	16	255
	PN10	s		547	323		258	-	445	400	22	12	180
	PN16	s		554	323		258	-	460	410	26	12	190
	PN25	s		567	323		-	334	485	430	29,5	16	210
300	PN40	s	900	582	323	550	-	334	515	450	32,5	16	230
	PN63	s		590	323		-	334	530	460	36	16	275
	ANSI150	s		566	323		258	-	482,6	431,8	25,4	12	200
	ANSI300	s		585	323		-	334	520,7	450,9	31,8	16	280
	ANSI600	s		604	323		-	334	558,8	489	35,1	20	360

* (G → housing versions: g - from cast irons; s - from steel with welded connecting pieces; f - from steel turned)

1.5. Construction

The turbine gas meter consists of 5 main components:

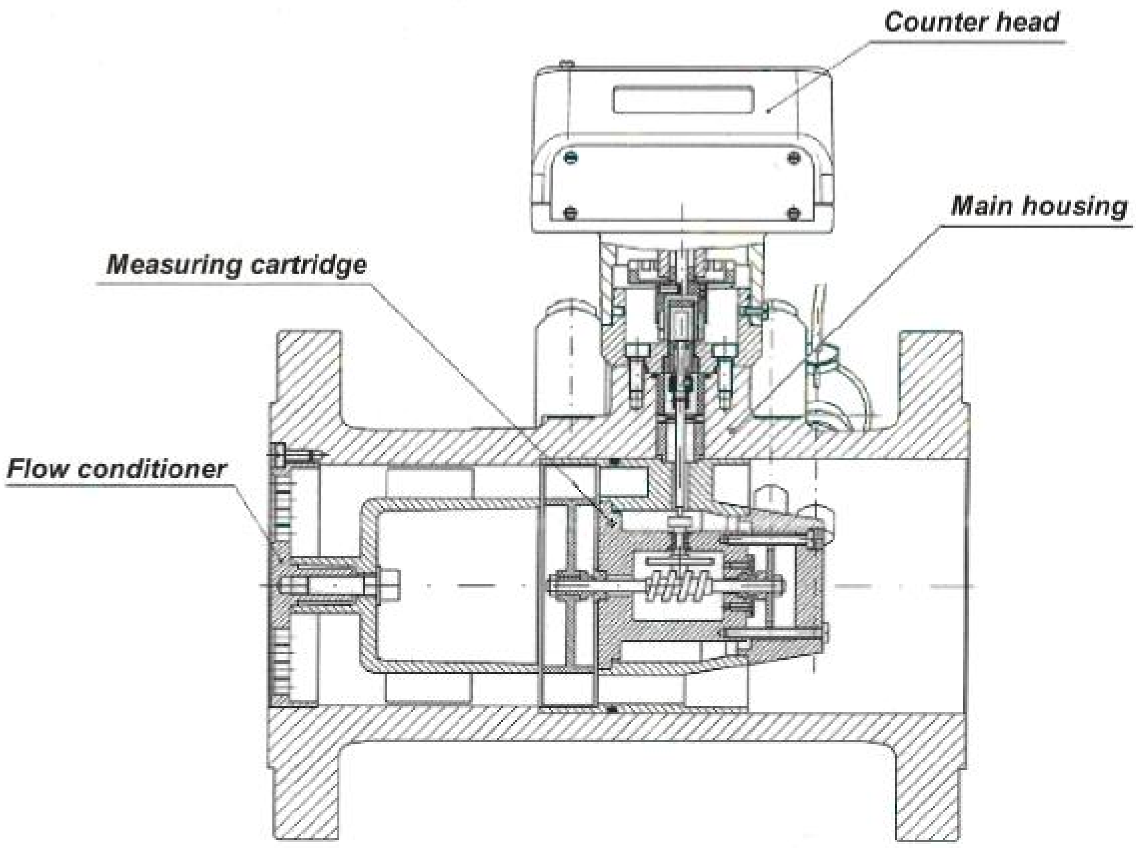


Figure 2: Sectional view of the turbine gas meters CGT

1.5.1. Main housing

Housings of the pressure rates to ANSI 150 and nominal sizes to DN 200 can be made of casting. For pressure rates to ANSI 600 the housings in smaller nominal sizes from forging steel are manufactured or welded together with larger nominal sizes from different parts. The dimensions and weights of the meters are indicated in table 3.
The installation of the meters is made by DIN or ANSI of flanges. For detecting of the operating pressure at the meter, is at the front and rear side one p_r - connecting piece each in form of a tapped hole M 12 x 1,5 available. Starting from nominal size DN 100, the installation of two temperature pockets into the meter body is possible.

1.5.2. Measuring cartridge

The measuring cartridge contains the turbine wheel and starting from nominal size DN 100 optionally the reference wheel, which are hold by means of lubricated or self lubricated ball bearings on the main shaft. The rotating motion of the main shaft will be reduced by gear wheels and transferred to the magnetic coupling.
A direct detecting of the rotating motion of the turbine- or reference wheel as high frequency impulse is additionally possible by the optional installation of up to two HF sensors each.

1.5.3. Counter head

The transfer of the angular momentum from the main housing loaded by pressure into the counter head is made by a gas tight magnetic coupling. In the counter heading a further reduction of the rotating speed of the waves is made by snail and gear wheels up to the drive of the 8-digit roll counter. A gear set is to be implemented changeable to realise an adjustment of the roll counter.
To pick up electrical impulses is given a possibility by up to two HF Namur sensors, up to two LF Namur sensors and up to two LF Reed contacts. As standard, each counter is equipped with one LF Reed contact. The electrical connection, to take the impulses from the counter head can take place over up to two sockets, whereby one socket is installed as standard. The output signals of the HF sensors in the counter operate adjustment-independently proportionally to the HF sensors on the turbine or reference wheel of the meter.

1.5.4. Flow conditioner

The turbine gas meter has an integrated flow conditioner on the upstream site. This ensures according to the OIML recommendation IR 32/89 are fulfilled concerning the incident flow.

1.5.5. Oil lubrication

Main shaft bearing of the turbine gas meters CGT can be executed self lubricated or with lubrication over oil pump. For the periodic lubrication the meter is equipped with a hand oil pump, with oil reservoir for an oil amount of filling up to 20 cm^3. All other bearings are self lubricated. Depending on the gas flow direction and installation position the oil pump can be attached in such a way that an operation of the front is possible.

1.6. Materials

All by the construction of the turbine gas meters CGT used materials guarantee the necessary stability and corrosion resistance. The meters are material-technically checked before distribution. Appropriate certificates in accordance with DIN EN 10204 can be requested.
Meter bodies of the nominal sizes to including DN150 and pressure rates to PN16 can be made from cast irons EN-GJS-400-15 or of steel ST3S. For bodies of the pressure rates up to ANSI 600 steel 18G2 or 19G2 is used. The housings are galvanised and outside coated with varnish paint.
Depending on the meter size, the integrated flow conditioner is manufactured from plastic or metal components, aluminium alloys partly combined with stainless steel.
The turbine wheel, the measuring cartridge, the meter body, as well as the oil pump are manufactured from aluminium alloys.
Moved parts like shafts, snails or bearings consist of stainless steel.
Gear and snail wheels are manufactured from plastic.
The transparent parts like counter displays or the oil reservoirs of the oil pump consist of polycarbonates.

1.7. Measurement and pulse outputs

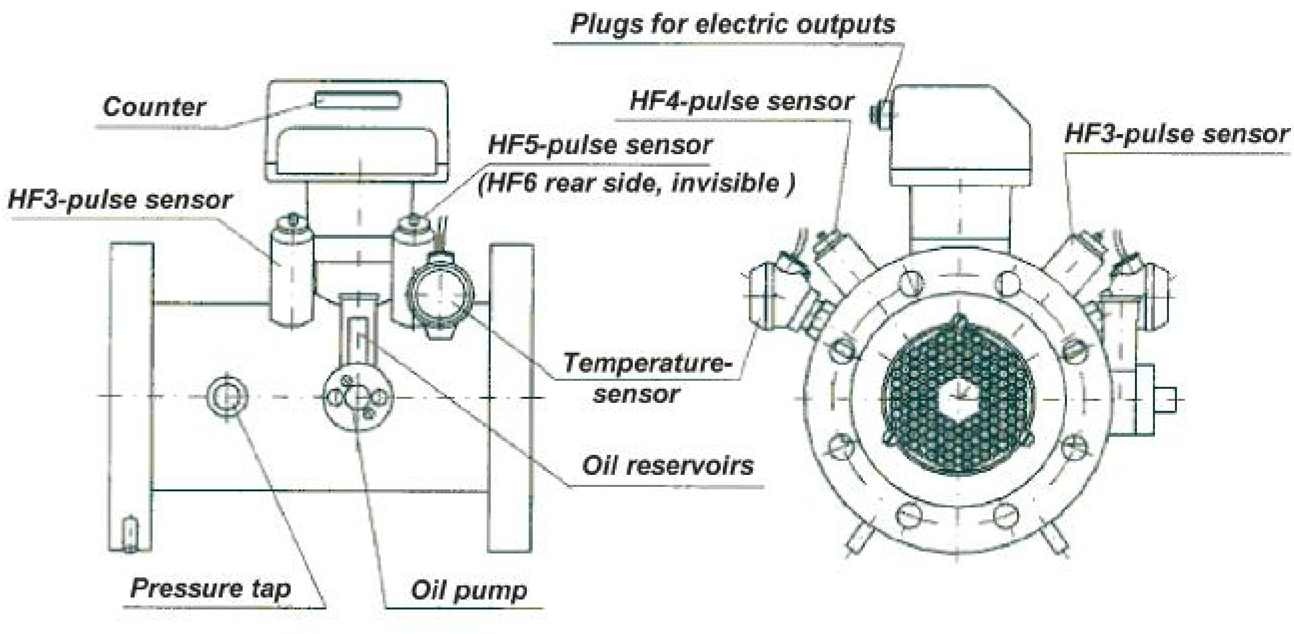


Figure 3: Measurement outputs of the turbine gas meter CGT

1.7.1. Counter head

The mechanical 8-digit roll counter head is the main counter of the turbine gas meter CGT. It displays the passed gas volume at operating pressure and operating temperature. Depending of the meter size, the display value corresponds to the lowest place 0.01 m³ up to 1 m³. The counter head is rotatable around 345°, so that it is configurable into almost all directions, in order to ensure a good readability in all installations.

1.7.2. LF-Reed-Contact

In the counter head Reed-Contacts (LF1 and LF2) are available depending upon execution up to two, whereby one Reed-Contact LF1 is equipped as standard. They are adjusted like the mechanical roll counter and output pulses, which are in direct relation to the mechanical display. This type of contacts is electric potential free and has a high long-term reliability. Mostly by Reed-Contacts battery powered devices are connected such as volume correctors or tariff devices. You find a representation of the position as well as the connection possibilities in the figures 6 and 7, as well as the specification of the pulse values in table 2. The technical data please take from the paragraph: „Technical data of the Reed-Contacts“.

1.7.3. LF-NAMUR-Pulse sensor

LF-NAMUR pulse generators are optionally possible up to two slot initiators (LF3 and LF4) in the counter head They are adjusted like the mechanical roll counter and the Reed-Contacts and output pulses, which are in direct relation to the mechanical display. The use of such active pulse generators is possible due to increased requirement of electric power consumption generally only with line power devices. Thus however pulses can be transferred over larger distances up to approximately 200 m surely. You find a representation of the position as well as the connection types in the figures 6 and 7 as well as the specification of the pulse values in table 2. The technical data please take from the paragraph: „Technical data of the NAMUR-Pulse sensors“. All pulse generators are certified for hazard areas and possess a EEx conformance certificate.

1.7.4. HF-NAMUR-Pulse sensor

HF NAMUR pulse generators are optionally possible in the counter heading (HF1 and HF2), at the turbine wheel (HF3 and HF4) and at the reference wheel (HF5 and HF6). The turbine gas meter can be equipped with these sensors according to demand of the customer. The output signals are in fixed relation to the rotation of the turbine wheel and can not be changed by the adjustment gear wheels. They serve generally the control of line powered volume correctors, flow computers or data storage devices. The pulses can be transferred over larger distances up to approximately 200 m surely. The specifications in the table 2 are approximate values, whereby the exact impulse values of an each sensor and meter are determined during the calibration and can deviate from the indicated value in table 2. The technical data please take from the paragraph: „Technical data of the NAMUR-Pulse sensors“. All pulse generators are certified for hazard areas and possess a EEx conformance certificate.

1.7.4.1.HF1 and HF2

This both pulse sensors are positioned in the counter head. There existing reference wheel generates the pulses in up to two approximation initiators (see fig. 4). You find a representation of the position as well as the connection possibilities in the figures 6 and 7.

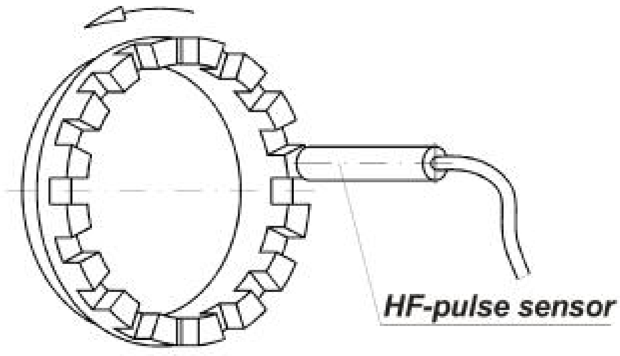


Figure 4: Representation of the HF-pulse sensors HF1 and HF2 in the counter head

1.7.4.2. HF3 up to HF6

The pulse sensors HF3 up to HF6 are positioned in the meter body (see fig. 3). The pulses of the turbine wheel are generated by the sensors HF3 and HF4 and the pulses of the reference wheel by the sensors HF5 and HF6, whereby the last two are only possible starting from the meters with nominal size DN100. Because the reference wheel is positioned on the same shaft like the turbine wheel and the numbers of frames on the reference wheel and the shovels of the turbine wheel are the same, all four pulse generators have the same output frequency. The sensors are approximation initiators and possess in each case a separate plug (see fig. 5).

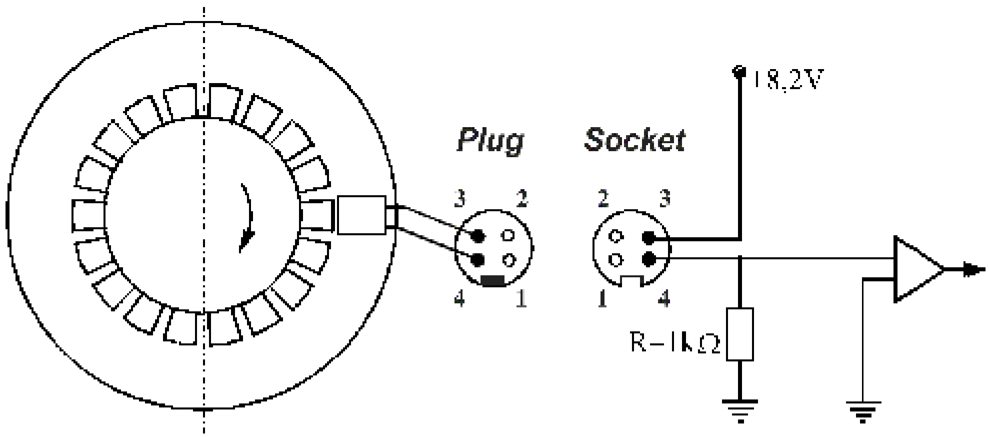


Figure 5: Pattern of the connectors of the HF pulse sensors HF3 up to HF6 in the meter body

1.7.5. Link specification of the electrical pulse sensors

Whether a pulse sensor is available and which impulse value of these possesses, you can take from the pulse generator sign of the turbine gas meter (fig. 14).

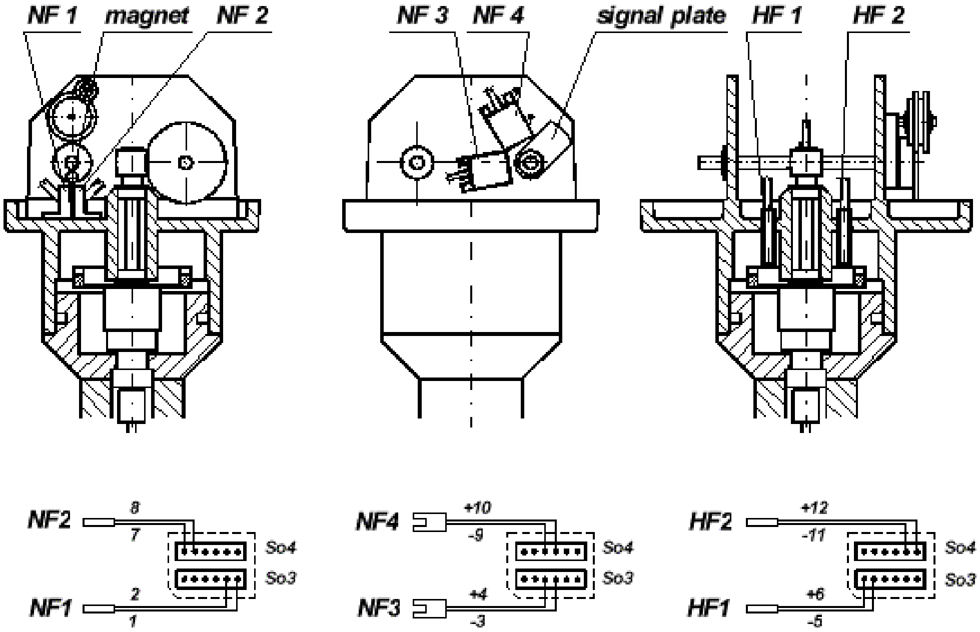
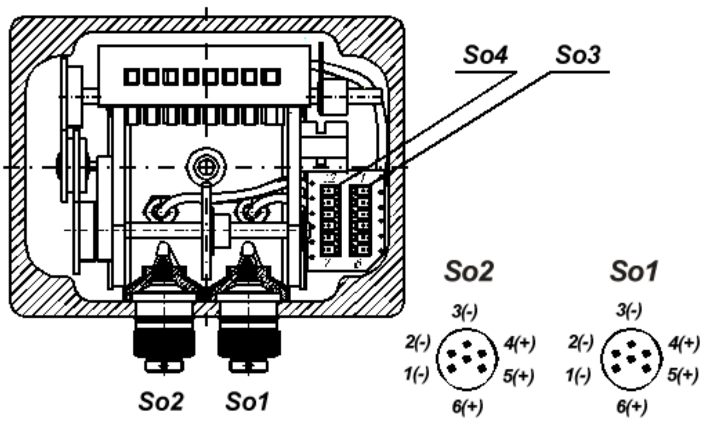


Figure 6: Position of the NF and HF pulse sensors in the counter head of the turbine gas meter CGT



			Socket 3						Socket 4					
			LF1		LF3		HF1		LF2		LF4		HF2	
	Pin	Polarity	1	2	3	4	5	6	7	8	9	10	11	12
Socket 1	1	–	x		x									
	4	+		x		x								
	2	–			x				x		x		x	
	5	+				x				x		x		x
	3	–					x							
	6	+						x						
Socket 2	1	–			x				x					
	4	+				x				x				
	2	–			x				x		x		x	
	5	+				x				x		x		x
	3	–					x						x	
	6	+						x						x

x - Standard connection of the complete version
x - Alternative connections

Figure 7: Diagram of connections of the pulse sensors in the counter head of the turbine gas meter CGT

1.7.5.1. *Pulse sensors in the counter head*

The position and the connectors of the possible pulse generators in the counter head are represented in the figures 6 and 7. The standard version contains only the LF Reed contact LF1. All other sensors can be installed on customer's request. The connection of the electrical pulses to the installation for clients is made by the sockets So1 and So2, whereby So2 is installed optionally with more than 3 sensors or on customer's request in the counter head. The electrical connection to the socket is to be implemented over a plug of the company Tuchel with the designation C091 31 H006 100 6. An information plate (see fig. 15) of the electrical specification of the socket is positioned on the rear side of the counter head.

1.7.5.2. *Pulse sensors in the meter body*

The position and the connectors of the possible pulse generators in the meter body are represented in the figure 3. The detection of the electrical impulses to the customer installation is made by the respective plugs at the sensor. The electrical connection could be realised to the 4-pin plug by a coupling socket of the company Tuchel with the designation C091 31 D004 100 2. An equipment of the meter with these sensors has to be required in the meter order. A retrofit is possible only, if the appropriate drilling with a thread hole M16x1,5 is available in the meter body, according to figure 8. This retrofitting can be done by the manufacturer only, or executed by assigned technical personnel.

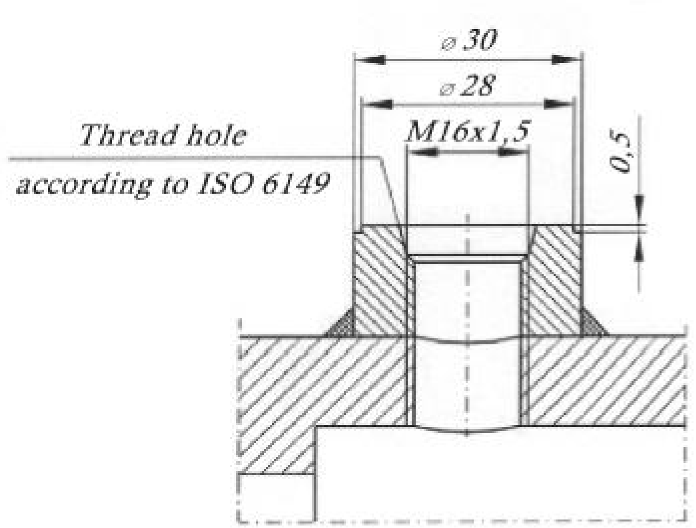


Figure 8: Assembly hole for the HF-Pulse sensors HF3 up to HF6 in the meter body

1.7.5.3. *Technical data of the Reed-Contacts*

The Reed-Contacts are passive sensors and used for low-frequency output signals only. They have the following technical data:

max switching voltage	24 V
max switching current	100 mA
contact resistance	0,15 Ω
max switching frequency	500 Hz

1.7.5.4.Technical data of the NAMUR-Pulse sensors

The NAMUR-Pulse generators are active sensors and used for low or high frequency output signals. They have the following technical data:

supply voltage	8,2 V
supply current inactive (low)	< 1,2 mA
supply current active (high)	> 2,1 mA
load resistance	1 kΩ
max switching frequency	5 kHz

The circuitry of the electrical connection is represented in figure 9 and the output signals which can be expected in figure 10.

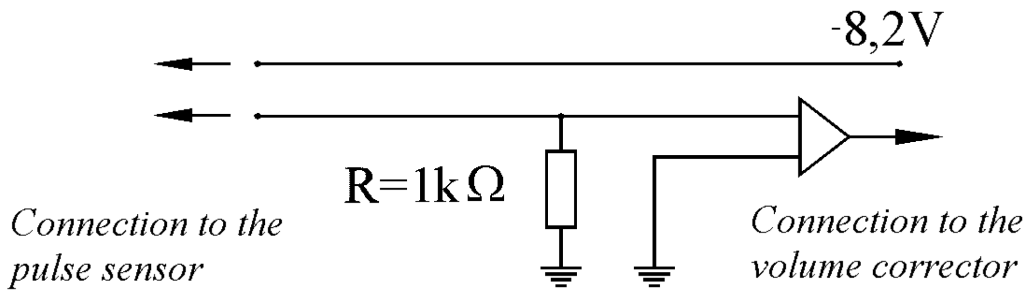
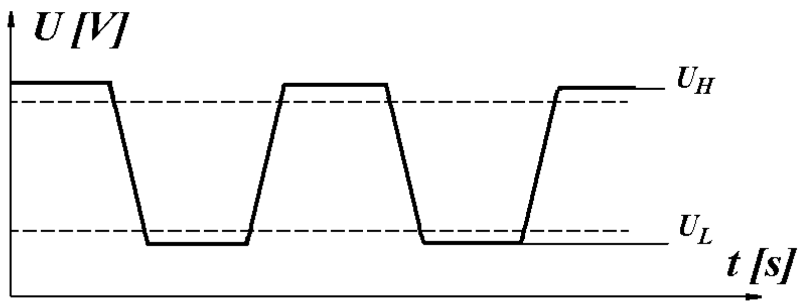


Figure 9: Diagram of connections of the inactive NAMUR initiators



inactive state: U_L < 1,2 V, active state: U_H > 2,1 V

Figure 10: Output signals of the inductive NAMUR initiators

1.7.6. Pressure measurement

The measurement of the operating pressure of the turbine gas meter can be done by the reference measuring tap p_r. These is available at the front and as doubles at the rear side of the meter (see fig. 3). In that way it will take place at the front without attention of the installation position. The thread dimensions for the connection of a screw connector is represented in the figure 11.

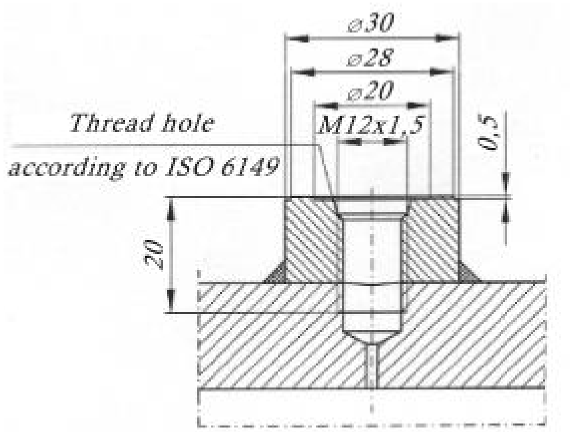
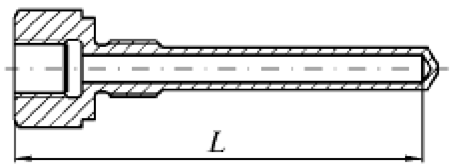


Figure 11: Dimensions of the reference measuring tap

1.7.7. Temperature measurement

The measurement of the operating temperature can take place in the turbine gas meter of the nominal size DN100 or larger by means of a temperature pocket, installed in the down stream part of the meter body(see fig. 3). The assembly of a second temperature pocket for the reference measurement is oppositely in the area with the same flow condition in the meter possible. In standard version no temperature pockets are installed, but can be ordered however as accessories. Temperature pocket possess an internal thread G ¼“ for the installation of a temperature sensor with a diameter of 6mm. The installation length please take from the figure 12. According to the request of the local verification offices the temperature pocket is to be filled with heat conducting oil or heat conducting paste.



DN	100	150	200	250	300
L [mm]	66	66	72	78	78

Figure 12: Temperature pocket for the installation into the turbine gas meter CGT

1.8. Designation and signs

The technical basic parameters of the turbine gas meter are noted on the type plate (fig. 13). It is equipped on the front of the counter head.
The specification concerning pulse outputs and their value can be taken from the pulse generator sign on the top side of the counter head (fig. 14).
The flow direction is indicated by arrows (fig. 16) on the front and rear side of the meter body.
The marking of the pressure and temperature measuring points takes place at the meter body according to the representation in figure 17. In similar manner also the pulse generators HF3 up to HF6 are marked.

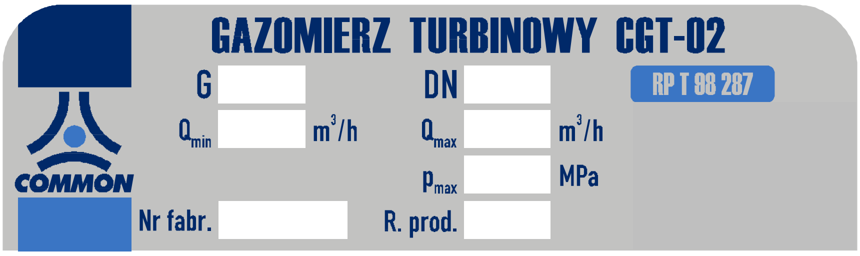


Figure 13: type plate

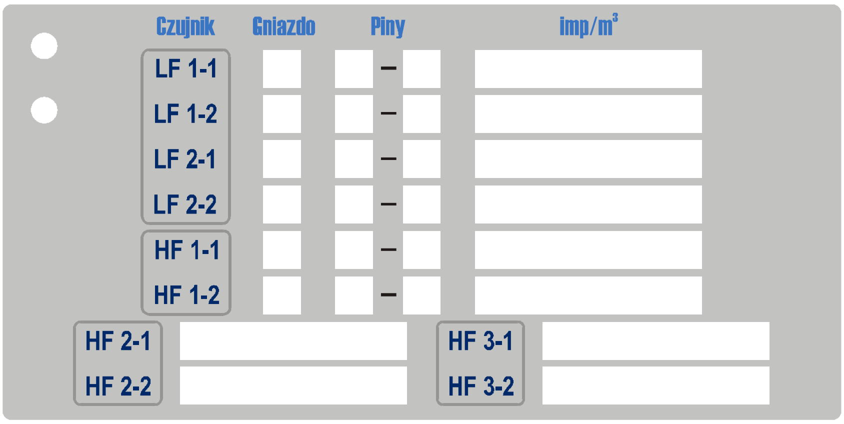


Figure 14: Pulse sensor sign

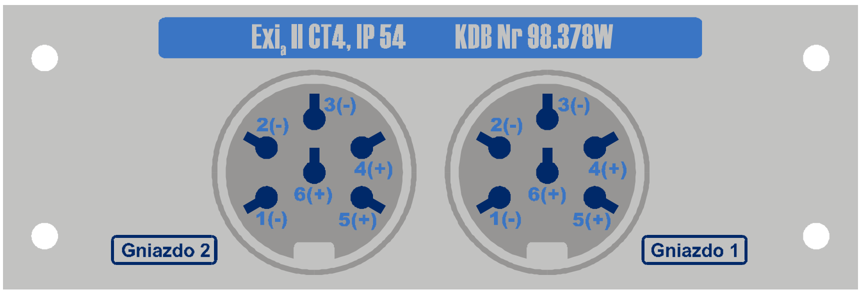


Figure 15: Sign for the connector identification of the pulse generators in the counter head

Figure 16: Arrow on the meter body for the specification of the flow direction

Figure 17: Information designation for the pressure and temperature measurement

2. Measuring values

The gas volume, which flows through a turbine gas meter, is displayed by the counter concerning the operating or line conditions pressure, temperature and compressibility only. In order to determine a comparable value independently to the respective operating conditions for accounting purposes, a conversion of the volume to standard conditions V_n is used. The standard volume determines itself from the following calculation:

$$V_n = \frac{V_b}{k} * \frac{p_b}{p_n} * \frac{T_n}{T_b} \approx \frac{V_b}{Z} * \frac{273 * (p_ü + 1)}{(t + 273)} \qquad (1)$$

where $k = Z/Z_n$

Definition:

V_b – operating volume [m³/h]
V_n – standard volume [m³/h]
p_b – operating pressure at the meter [bar]
$p_ü$ – operating over pressure at the meter [bar]
p_n – standard pressure [bar] (1,01325 bar)
t – operating gas temperature [°C]
T_b – standard gas temperature abs. [K] (273,15 K)
T_n – operating gas temperature abs. [K]
k – compressibility factor k (constant or calculation by GERG 88)
Z – real gas factor
Z_n – real gas factor (standard condition: $Z_n \cong 1$)

The operation volume V_b of an accounting period determines itself from the difference of the counter statuses of the turbine gas meter the at the beginning and to the end of the period. The operation over pressure $p_ü$ is determined on the reference pressure point p_r of the meter as average value. The operation gas temperature t is determined as average value measured by a temperature sensor in the meter body or in the down stream pipe of the meter in accordance with PTB test rules Volume 20. The compressibility factor is determined by using the gas quality, at systems up to 10 bar as constant or at higher pressures than variable over calculation methods in accordance with G 486.

3. Measuring accuracy

Each real measurement is falsified by measurement inaccuracies. These errors can be divided at the turbine gas meter in two substantial categories:

1. Error by the physical characteristics of the measurement principle.
2. Error by the installation-conditioned influence of the gas flow.

3.1. Error of the measurement principle

The measuring characteristic of turbine gas meters is represented in figure 18. According to the EWG guideline of volume gas meters the margins of error are determined on the following values:

$Q_t – Q_{max} \quad \leq \pm 1\%$
$Q_{min} – Q_t \quad \leq \pm 2\%$

where at turbine gas meter $Q_t = 0,2\ Q_{max}$

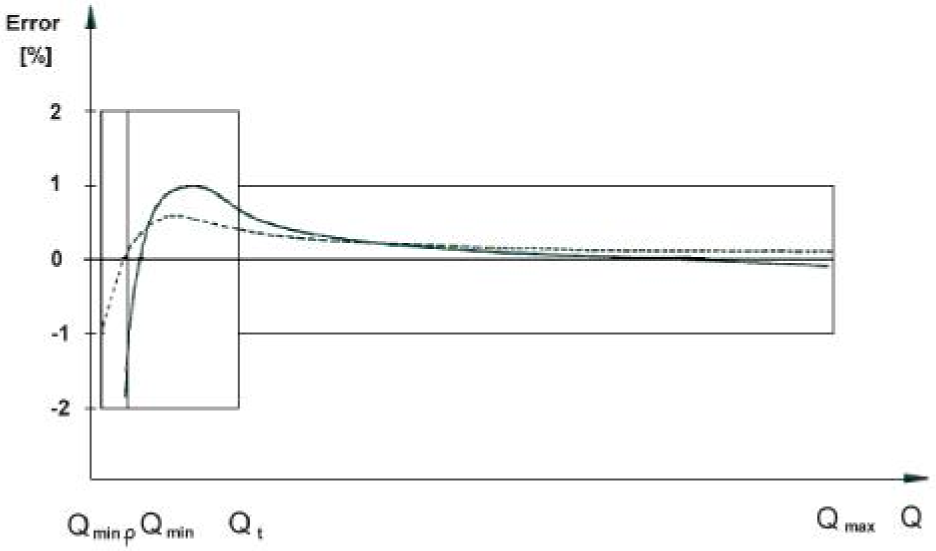


Figure 18: Error characteristic of a turbine gas meter
¾ ¾ ¾ Low pressure error curve; - - - - - - High pressure error curve

The measurement range of the COMMON turbine gas meters is indicated in table 2. As more highly the operating pressure rises, becomes the error curve more flatter (see fig. 18) and the minimum flow Q_{min} becomes more smaller within the admissible limits of error. Thus a larger measuring range can be obtained with higher operating pressures, which can be certified up to a relation of 1:50.
The on density depending minimum flow value $Q_{min,\rho}$ can be calculated according to the following relation:

$$Q_{min,\rho} = Q_{min} * i_\rho = Q_{min} * \sqrt{\frac{\rho_w}{\rho}} = Q_{min} * \sqrt{\frac{\rho_w * 1{,}013}{\rho_g * (p + p_a)}} \approx 1{,}1 * \frac{Q_{min}}{\sqrt{\rho_g * (p + p_a)}} \qquad (2)$$

Definition:
$Q_{min,\rho}$ – minimum flow value under operating pressure [m³/h]
Q_{min} – minimum flow value according to table 2 [m³/h]
i_ρ – coefficient
ρ_w – density of the gas of the verification [kg/m³]
ρ – density of the operation gas with operating pressure [kg/m³]
ρ_g – density of the operation gas with atmospheric pressure according to table 1 [kg/m³]
p – gas overpressure in front of the turbine gas meter [bar]
p_a – atmospheric pressure [bar]

The figure 19 shows a diagram to the determination of $Q_{min,\rho}$ with determined operating pressure. Based on the operating pressure and the temperature it has to be determined the density. In dependency of this density values, the coefficient i_ρ can be determined from the right page of the diagram. Under help of the formula in the diagram (fig. 19) it is possible to calculate the appropriate $Q_{min,\rho}$ under operating pressure by using the Q_{min} value from table 2.

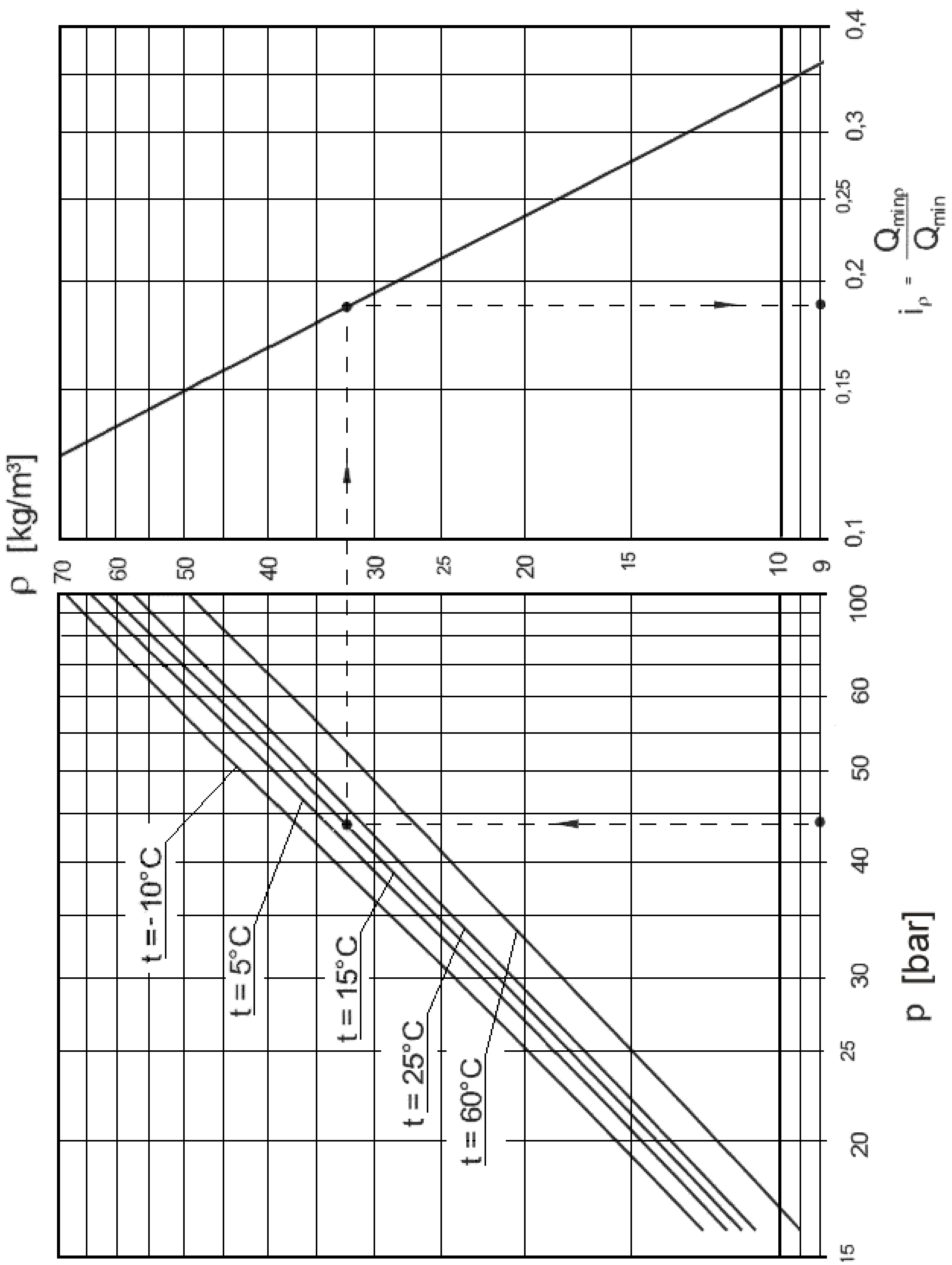


Figure 19: *Diagram for the determination of the Q_{min} - value at defined operating pressure and operating temperature*

3.2. Error of the installation

Turbine gas meters are inferential gas meters and therefore dependent on the direction, distribution and the homogeneity of the gas flow.
The integrated flow conditioner guarantees under considering of the minimum requirements as per OIML recommendation IR 32/89 also without additional flow conditioner in the upstream pipe the adherence of the error limits. There it means, that with an upstream pipe length of 2xD regardless of any perturbations the error deviation is not larger than 0.3%.
In the case of pulsating or intermittent gas flows, which cause a run after of the turbine wheel of over 1% in relation to the operation flow, a turbine gas meter without special add-on modules is not suitable. In these cases volume measuring instruments should be used, as for example the COMMON rotary gas meters CGR.

4. Pressure loss

The gas meter causes an inevitable pressure loss. This is limited by the maximum value according to DIN 33800. The pressure loss values of the individual nominal sizes at a gas density $\rho_0 = 1 kg/m^3$, that can be taken from the diagram of the figure 20.
The real pressure loss Δp_{re} is calculated according to the following formula:

$$\Delta p_{re} = \frac{\rho}{\rho_0} * \frac{p_a + p}{p_a} \Delta p \qquad (3)$$

Definition:
ρ – gas density according to table 1
ρ_0 – reference gas density ($\rho_0 = 1 kg/m^3$)
Δp – pressure loss for gas density ρ_0 (Abb.20)
Δp_{re} – operating pressure loss
p – gas over pressure in front of the meter
p_a – atmospheric pressure ($p_a = 1bar$)

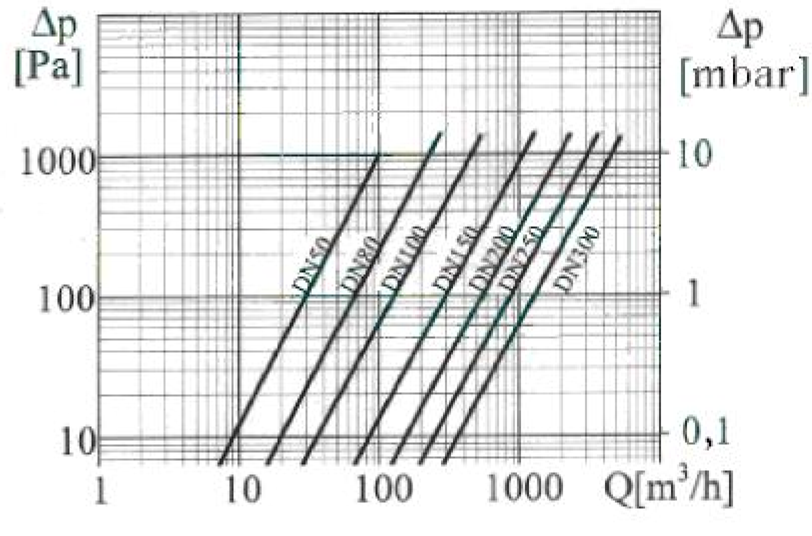


Figure 20: Pressure loss diagram of the turbine gas meter CGT of a density $r_0 = 1 kg/m^3$

In the case if a complete meter run with upstream and downstream pipe, temperature pockets and a Sprenkle flow conditioner will be used, a calculation of the pressure loss by the same formula is possible. The pressure loss value Δp of the complete meter run is to be inferred thereby from the pressure loss diagram in figure 21.

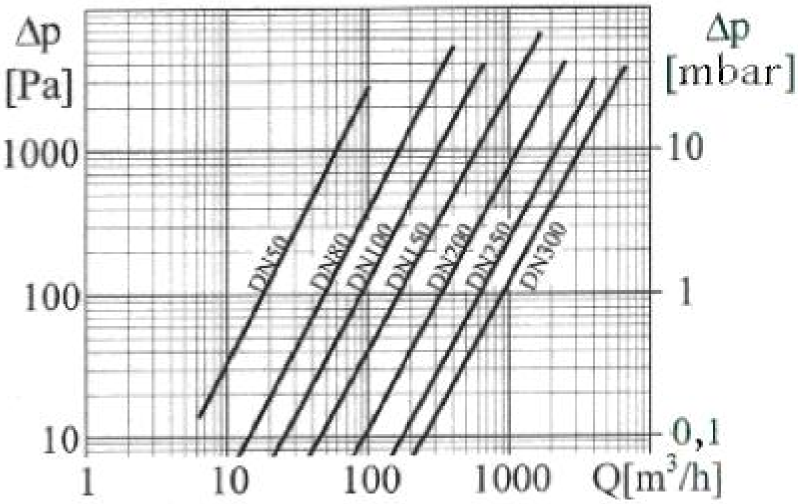


Figure 21: Pressure loss diagram meter run of a density $r_0 = 1$ kg/m^3

5. Transport and storage

The turbine gas meter CGT is a precise measuring instrument and is to handle with the utmost caution.
The following points are to be considered:
During transportation the meter is not to be thrown or to expose strong vibrations. Special caution is required for loading and unloaded of high pressure meters, in the case of a large mass.
The transportation of the meter has to be done with emptied storage vessel of the oil pump.
The meter is to be transported and to be stocked in the appropriate installation position. At meters with oil pump it is to be paid attention, that they may be brought only briefly into another position than the installation position.
The gas meter should be transported in the original packaging up to the place of work.
Removing from fabrication catches and transportation covers is only recommendable at the installation place.
A raising of the turbine gas meter at the counter head is not admissible. For the movement of heavy devices the transport eyes are to be used.
It is to be paid attention to as dry a storage as possible. The meter is to be protected against precipitation and other humidity.
It is to be made certain that by the transportation and by remove of the packing no verification seal is damaged or is removed, since otherwise the official verification is lost.
Storing gas meters do not need to be lubricated.
For mentioned above transport damages the manufacturer does not take over a warranty.

6. Installation

Before the gas meter is installed, it should be checked again, if the meter meets the requirements of to the gas measuring system. Very important is the check of the pressure rate PN of the installation, the maximum installation pressure p_{max} and maximum the flow rate Q_{max} under operating conditions, as well as the right flow direction.
The preferred position for the installation of the turbine gas meter is an horizontal installation. The counter head has to be above in each case. A vertical installation has to be adapt by the production. Specially the flow direction from down upward is to be avoided and possible only by special manufacturing.
The gas meter has not to be installed at the deepest point of the installation, because otherwise condensate or contamination can settle in the meter and thus the function and measuring accuracy can be affected.
The installation of turbine gas meters should take place in closed rooms or cabinets if possible. In open air installations the meter has to be protected by suitable measures from precipitation, contamination or direct sun exposure. The area of application is with a gas temperature between -10°C and +60°C. The lowest ambient temperature has to be not lower than -25°C.
The COMMON turbine gas meter passed the perturbation approval according to the OIML recommendation IR-32/89, annex A with easier and heavy perturbation. For installation of COMMON turbine gas meters an upstream pipe distance of 2 x DN is sufficient. It is to be made certain too, that the gas flow does not indicate an intermittent or pulsating character, which can cause a tracking error of $\geq$1%.
In order to achieve a very high measuring accuracy of the gas meter, the company offers also complete meter runs with upstream and downstream pipe, temperature pockets in the downstream pipe and a COMMON flow straighter. This flow straighter is a Sprenkle Flow conditioner according to DIN EN ISO 5167-1. The pressure loss thus increased is to be inferred from the paragraph of the same name.
The installation of the gas meter has to take place without tension into the piping. With larger meters the pipe installation, or if necessary the meter, is to be supported. It is to be made certain that the meter is to be built concentrically into the piping and no seals loom into the piping.
It has to be paid attention of possible contamination of the gas, which can damage the meter and cause an influence of the measuring accuracy strongly. If possible, a filter has to be installed in front of gas meter, which has a fineness of minimal 10µm. In the starting phase a start sieve is recommendable, which avoids a damage of the meters by welding or installation pollution. This is to be removed however after some time again from the pipe installation, in the case of contamination which were held back by the start sieve, will generate a flow disturbance, which can have an influence on the measuring accuracy. The manufacturer of the turbine gas meters does not take responsibility for damage to the gas meter, which from insufficient filtering or contamination in the piping results.

The connection of volume correctors and add-on modules has to take place using the prescribed plug connectors (paragraph "link specification of the electrical pulse generators").

7. Putting into operation

If the gas meter is equipped with an oil pump, the bearings have to be lubricated in accordance with servicing instruction before start-up.
During the admission of the turbine gas meter with operating pressure largest caution is required, because by the difference of pressure for pressure-free subsequent installation briefly large gas flows can occur, which can load then the gas meter over the permitted flow and destroy the measuring cartridge. Filling the pipe installation by the installed turbine gas meter should be avoided. You find an example of the structure of a measuring system in figure 22.

- case a bypass in the installation is available, is before opening the valves 1 and 2 pre and behind the gas meter the following piping through to open the valve 4, to be filled. Afterwards over a needle valve 5, if it is available, or by very slow opening of input valve 1 the meter can be set under operating pressure. After it the output valve 2 is only opened slowly. As last step may not be forgotten to close the valves 4 and 5 again.
- with absence of the bypass at first the meter is by slow opening of the output valve 2 to connect with that follows installation. Afterwards very slowly and carefully the input valve 1 is to be opened, whereby the danger of the brief overload is very large here.
- for the purpose of the disassembly the meter installation has to be emptied. If a bypass is available, the valve 4 is opened as the first one. The meter has to be separated from the gas flow by slowly close from the input valve 1 and the output valve 2. Afterwards the gas meter is to be emptied over the bleed valve 3 slowly.

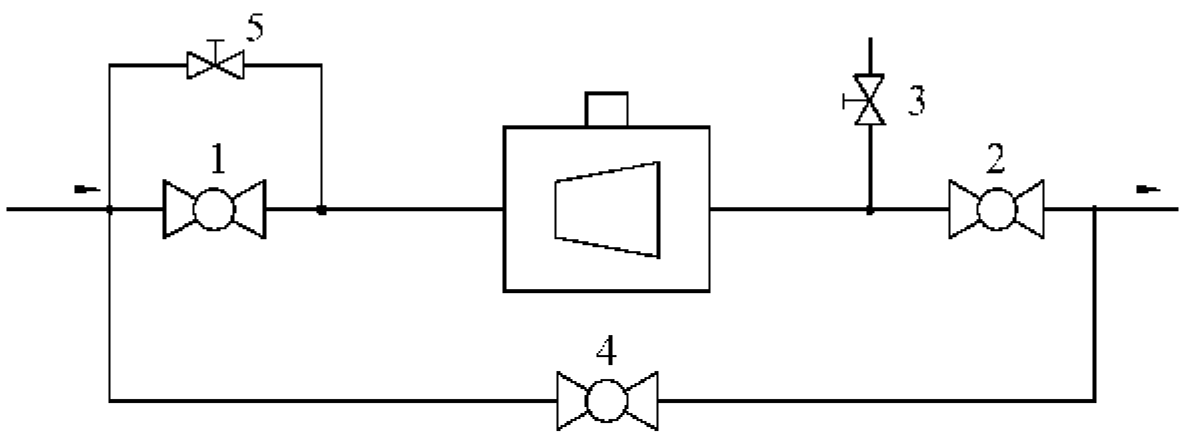


Figure 22: Pattern of a measuring system with bypass

8. Maintenance and lubrication

Turbine gas meters has to be serviced from instructed technical personnel only. Strong operation noises or jerky run point on a damage of the gas meter. Additional there is a

controllability, if pulses of the reference wheel and the turbine wheel of the turbine gas meter are compared by a volume corrector or a flow computer. The deviations of the relation of the calibrated impulse values must be below 1%. In these cases the meter is to be repaired by the manufacturer or a certified workshop. To put the meter into custody transfer again, the meter has to be official verified one's more.
Turbine gas meters with oil pump are to be lubricated periodically. Depending of the composition of the gas escort substances and the stressing of the turbine gas meter, by the measurement application of gases of the 2. gas family according to G 260/I, a lubrication all 1 to 2 months is recommend. With the application for the measurement of rotten gas, strongly dirty or other aggressive gases, the reduction of the lubrication interval by 1 time weekly is necessary. For measurement other gases please co-ordinate the lubricant with our factory, which can be used.
Depending upon pressure range the turbine gas meter can be equipped with a pushbutton oil pump or a lever oil pump. A complete stroke of the oil pump supplies approx. $^1/_3$ cm³ oil to the main bearings. The recommended stroke rate for a lubrication cycle is indicated in table 4.

Table 4 Recommended stroke rate of the oil pump for each lubrication cycle

Nominal size	Stroke rate
DN50, DN80, DN100	5
DN150, DN200	10
DN 250, DN300	15

At each lubricating the oil level in the storage vessel of the oil pump is to be controlled. To the refill Lubrina oil of the company COMMON is recommended. The following Lubrina types of oil are offered by COMMON for it:

DN50 and DN80	Lubrina-Öl L12	Viscosity approx.12 mm²/s at 20°C
≥DN100	Lubrina-Öl L23	Viscosity approx. 23 mm²/s at 20°C

For in table 1 specified gases the following of oils can be used too:

DN50 and DN80	Isoflex PDP10
≥DN100	Isoflex PDP38 or Aeroshell Fluid 12

9. Verification

The gas meter loses its permission for the application of custody transfer, if a seal were damaged or removed. The seal positions can be taken from the figure 23.

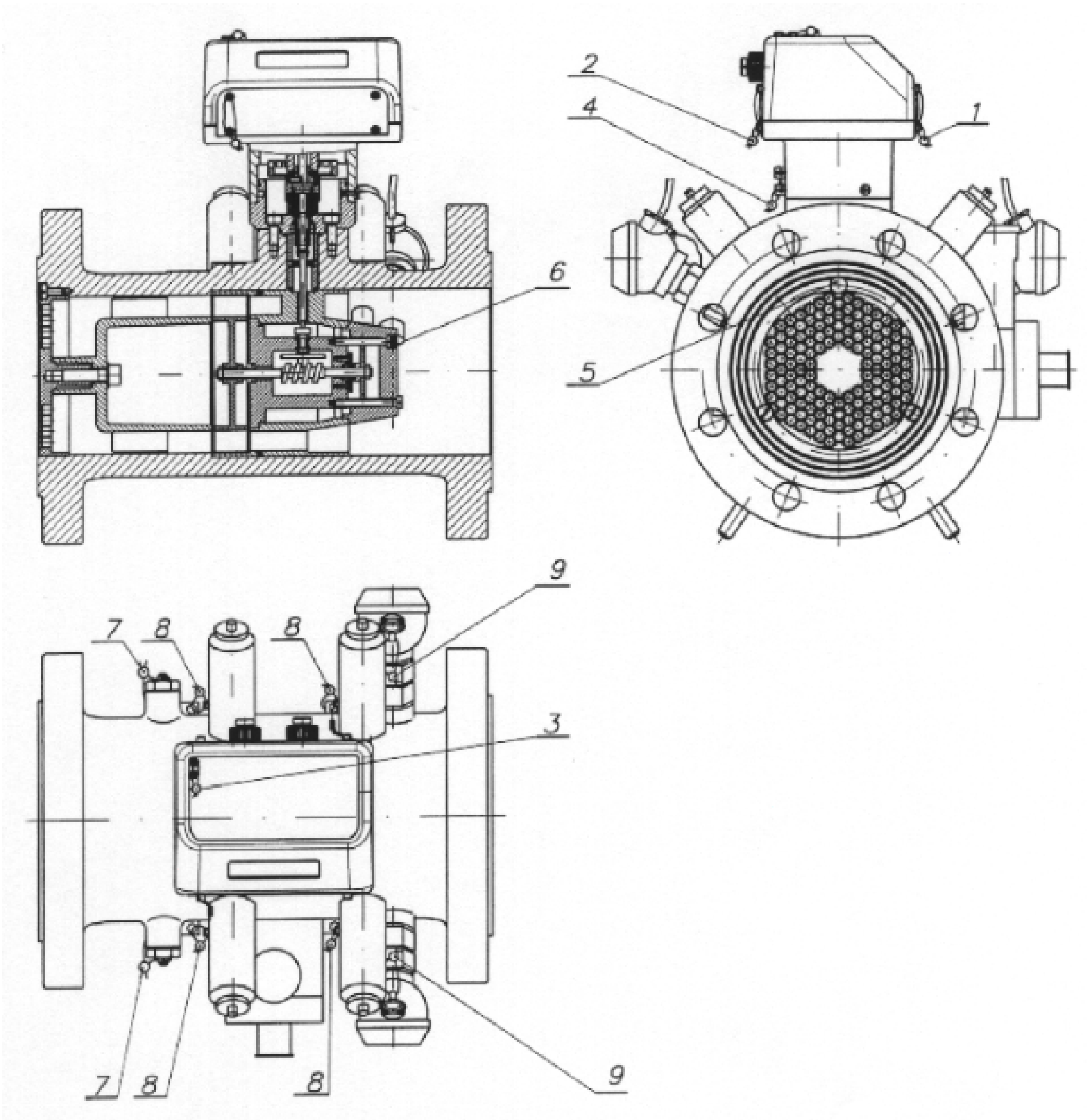


Figure 23: Seal positions of the turbine gas meter CGT

Seals for add-on modules are not marked. At special information it is pointed out, that blind screw connections which are not be used by sensors, can be sealed too. Also with a break of these apparently unnecessary security seals the calibration validity of the measuring instrument goes out.