

# Turbocharger



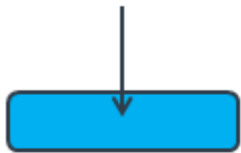


## MAN L 28/32H Diesel Engine Turbocharger Description

# Turbo charger basics system



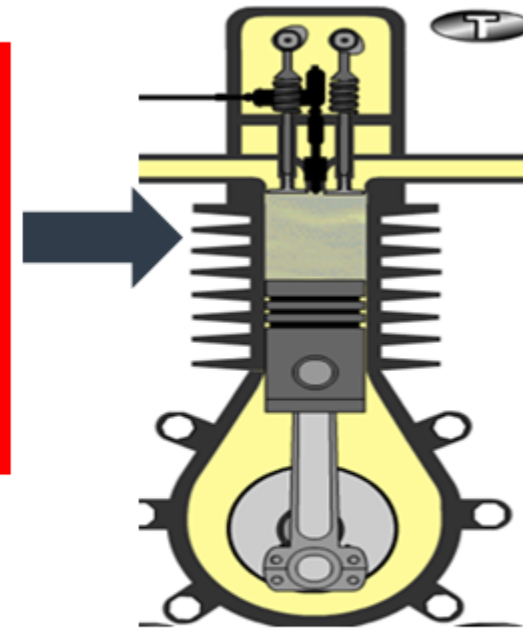
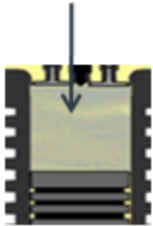
2 liter luft, 21% ilt = 0,42 liter ilt  
2 litre air, 21% oxygen = 0,42 litre oxygen



Komprimeres de 2 liter til 1 liter  
kan vi få 0,42 liter ilt i motoren, hvorved vi  
kan forbrænde dobbelt så meget brændstof  
og få den dobbelte ydelse ud af motoren !

Compress 2 l. air into 1 l air, then we can get 0,42 l  
oxygen in the engine and we can burn the doublet amount  
of fuel, and get the double output out of the engine.

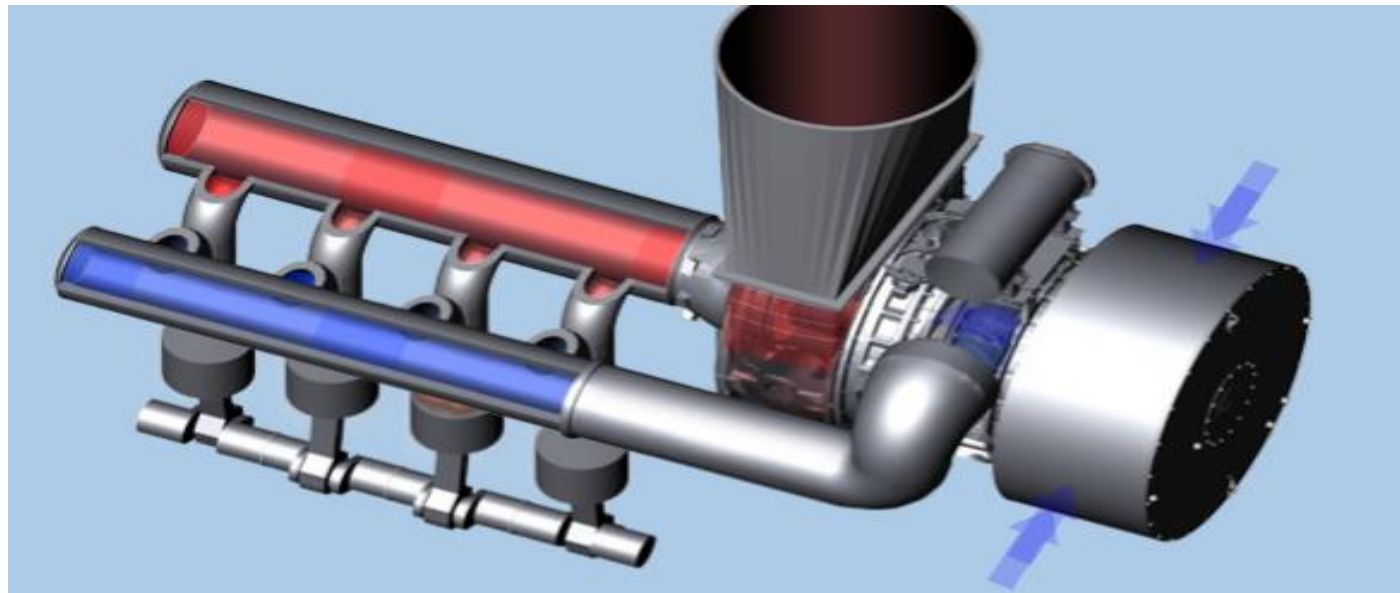
1 liter luft, 21% ilt = 0,21 liter ilt



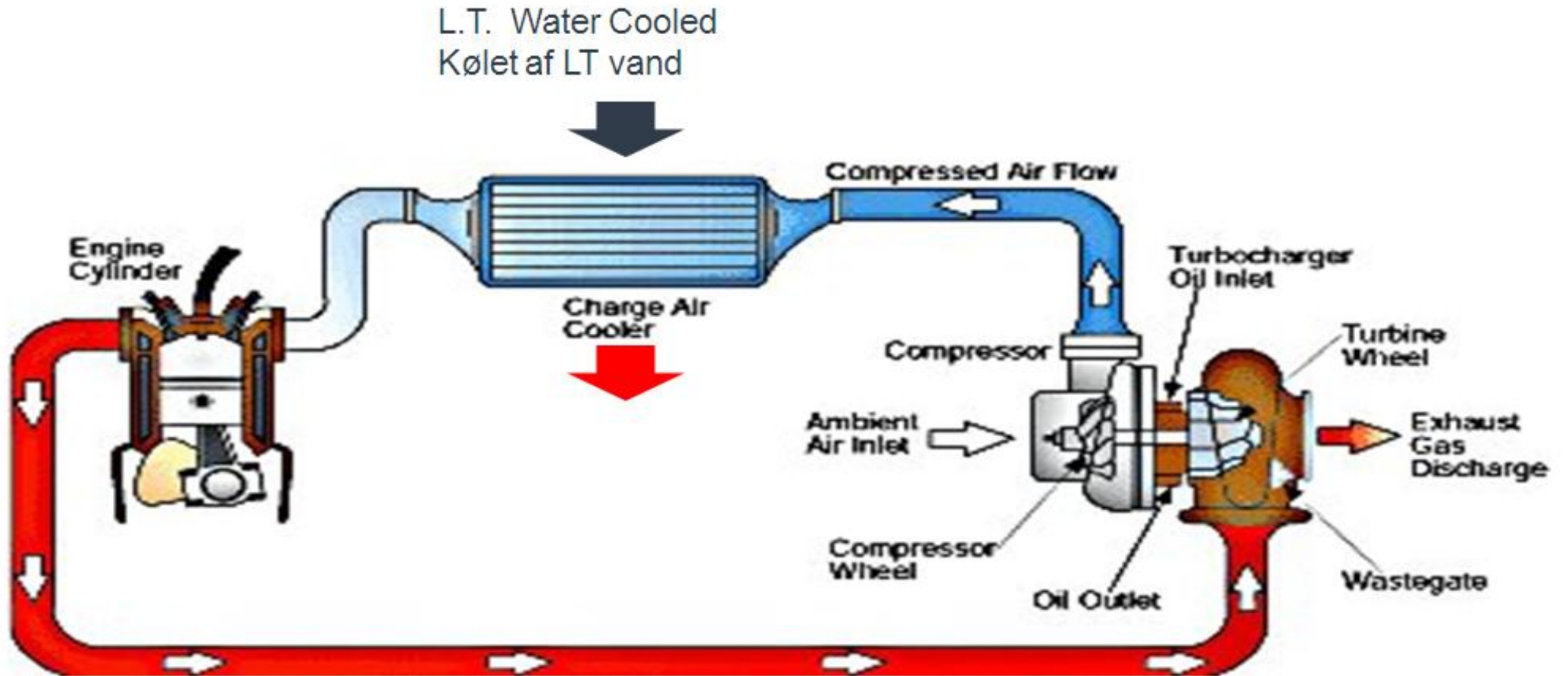
# Turbo charger basics system



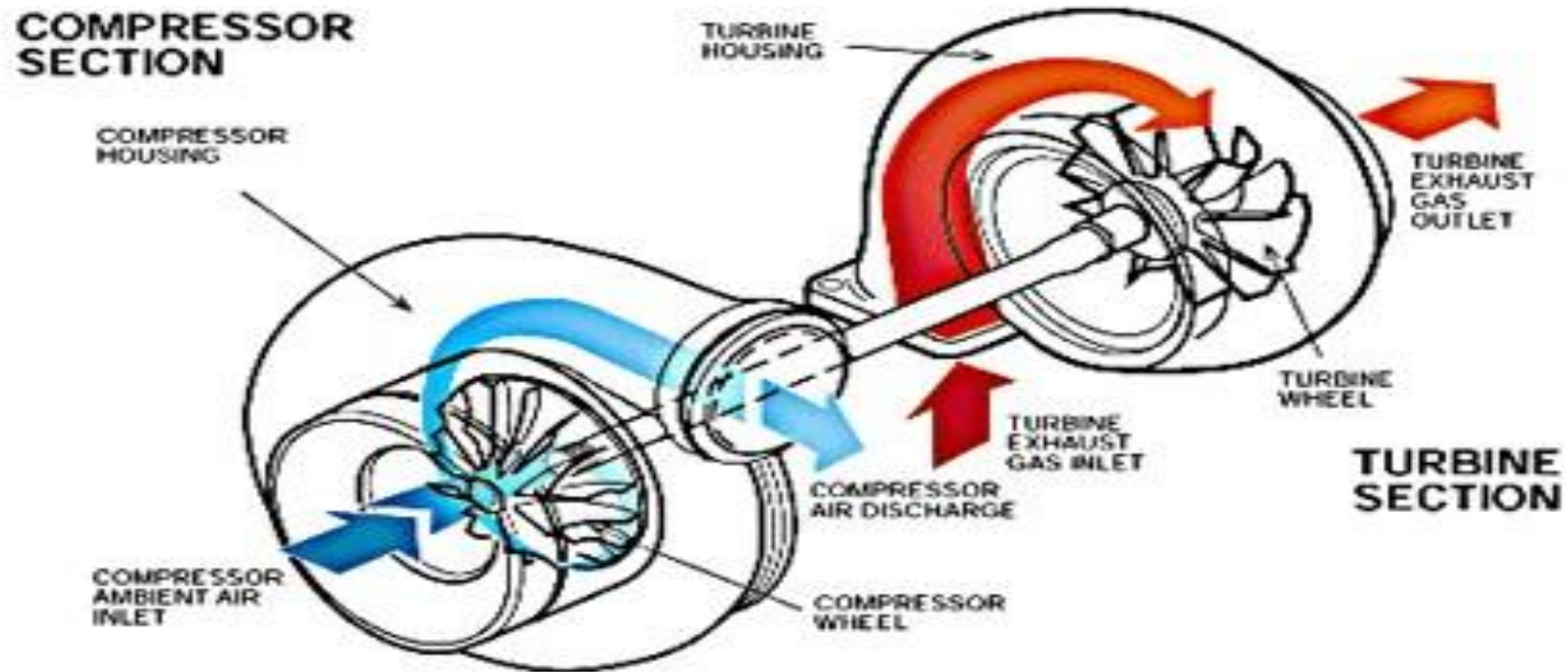
A turbocharger consists of a turbine and a compressor linked by a shared axle. Exhaust gases from the engine causing the turbine wheel to rotate. This rotation drives the compressor, compressing ambient air and delivering it to the air intake manifold of the engine at higher pressure. Compressed air is then led through a charge air cooler before entering the charge air receiver.



# Turbo charger basics system



# NR Turbo charger basic system

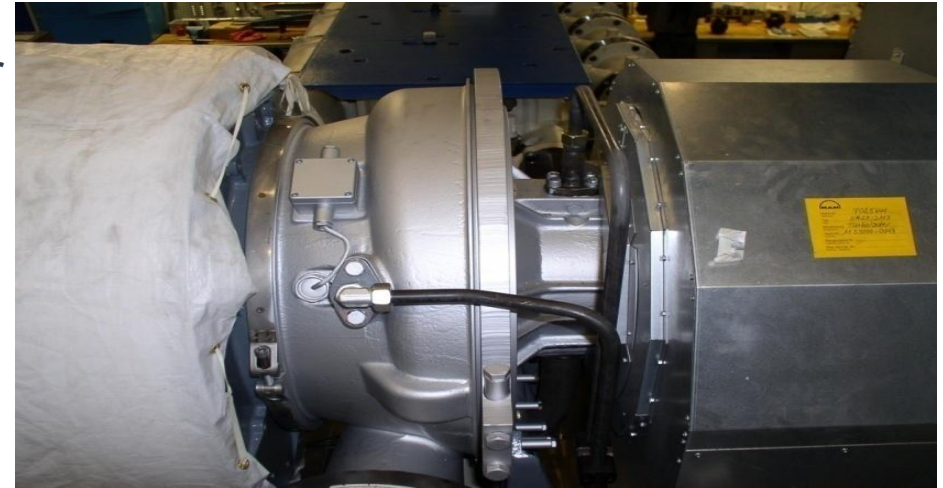


# NR Turbo charger basic system

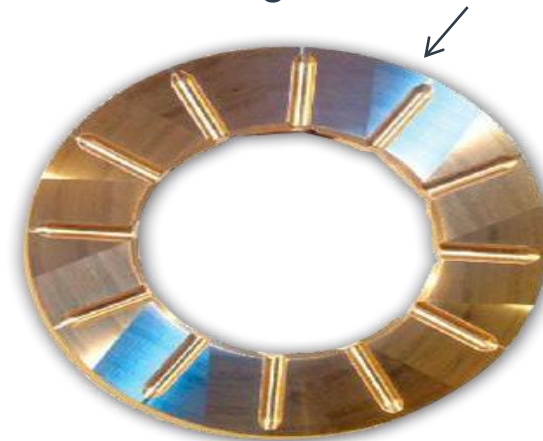
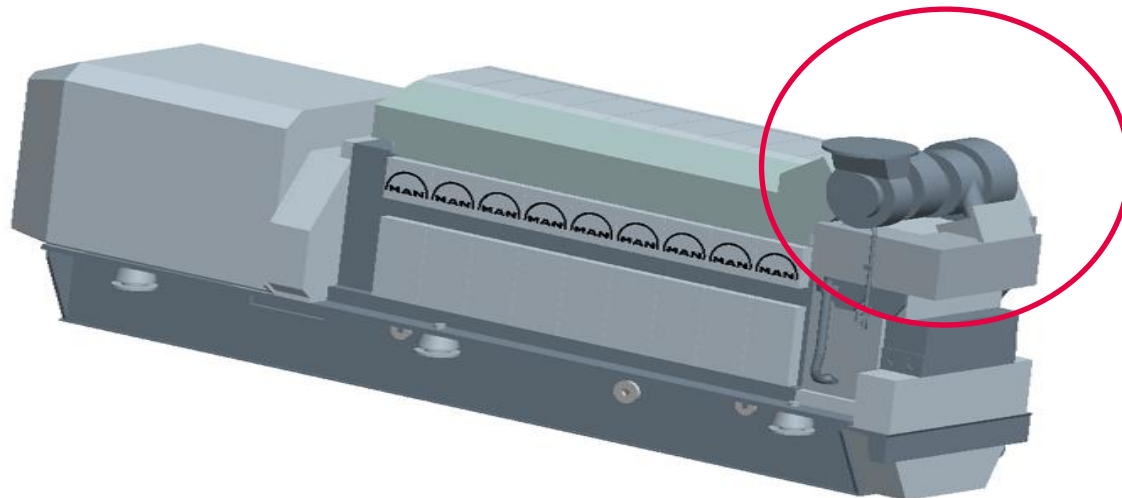


## MAN Diesel turbocharger

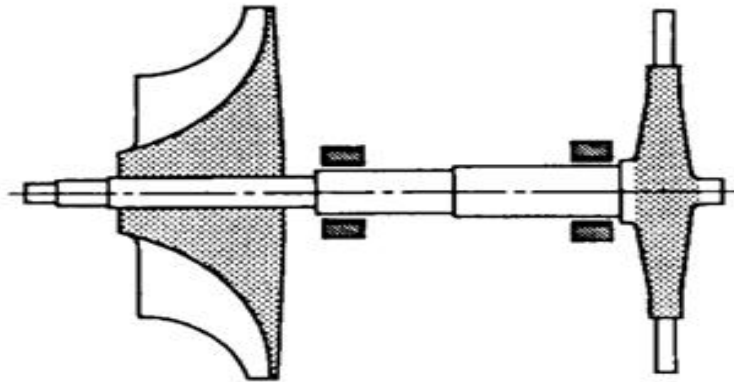
- Plain bearings
- Inboard bearing arrangement
- Uncooled hot gas casing
- Lubrication by the engine lube oil system.



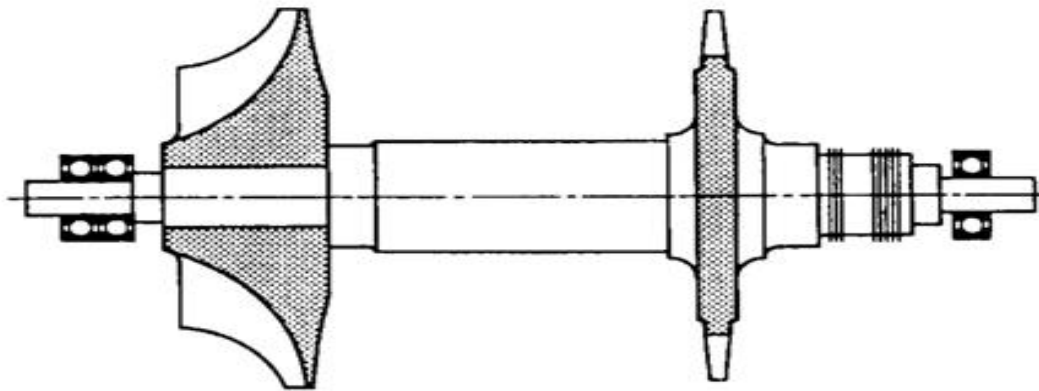
Plain bearing



# Principle systems of bearing arrangements



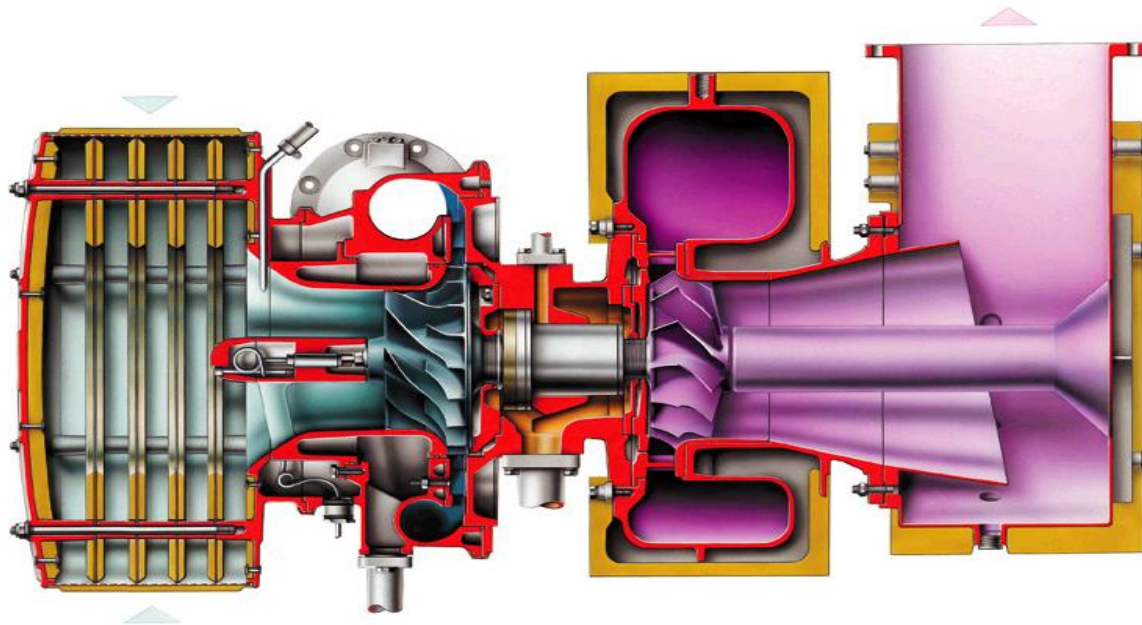
**inboard plain bearings**  
(MAN Diesel turbochargers)



**outboard roller bearings**  
(other manufactures)



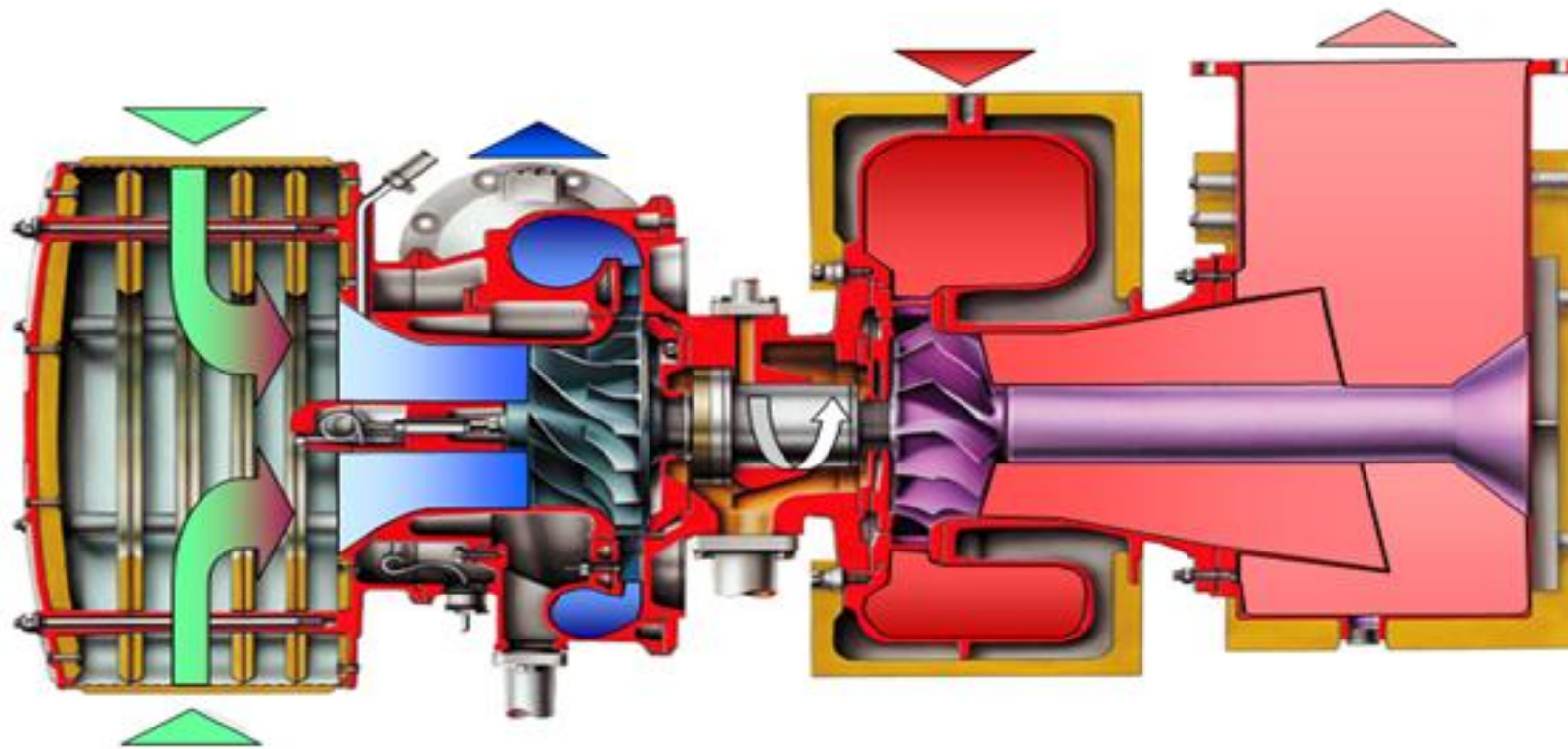
# NR Turbo charger basics system



- 1 turbinerotor with shaft
- 2 compressor wheel
- 3 bearing casing
- 4 plain bearing
- 5 gas admission casing
- 6 nozzle ring
- 7 gas outlet diffuser
- 8 gas outlet casing
- 9 compressor casing
- 10 diffuser
- 11 silencer



# NR Turbo charger basics system



# Turbo charger system

## Designation of NR turbocharger



**R** for  
"Radial Flow Turbine"

**S** = letter for designation of the design  
status (**S** = latest design)

**N R 20 / S 010**

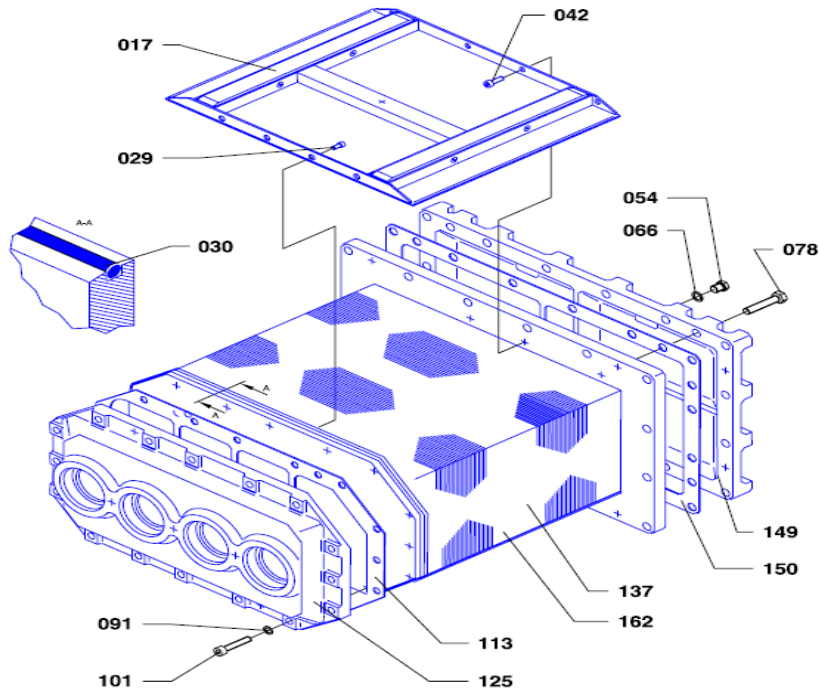
**N** for German word  
"Norm"

**20** for the frame  
size=nominal outer  
diameter of  
compressor  
wheel in cm

**010** = Specification  
Number (related to the  
specific engine and the  
installed flow  
components)

# Turbo charger system

## Charge air cooler



A charge air cooler is used to cool air after it has passed through a turbocharger, but before it enters the engine.

Charge air coolers range in size depending on the engine.

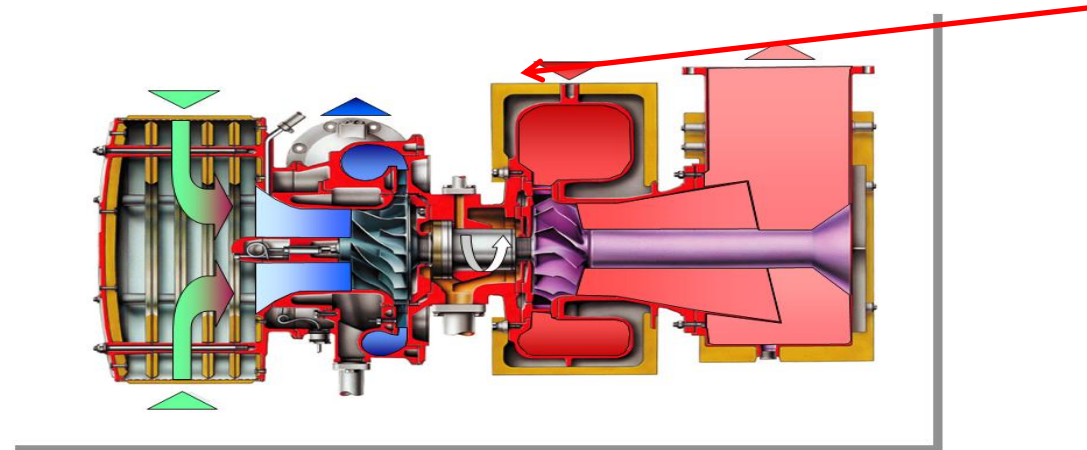
Vestas air coil A/S and GEA are the oldest makers still in business.

# NR Turbo charger system

## Cleaning turbine side

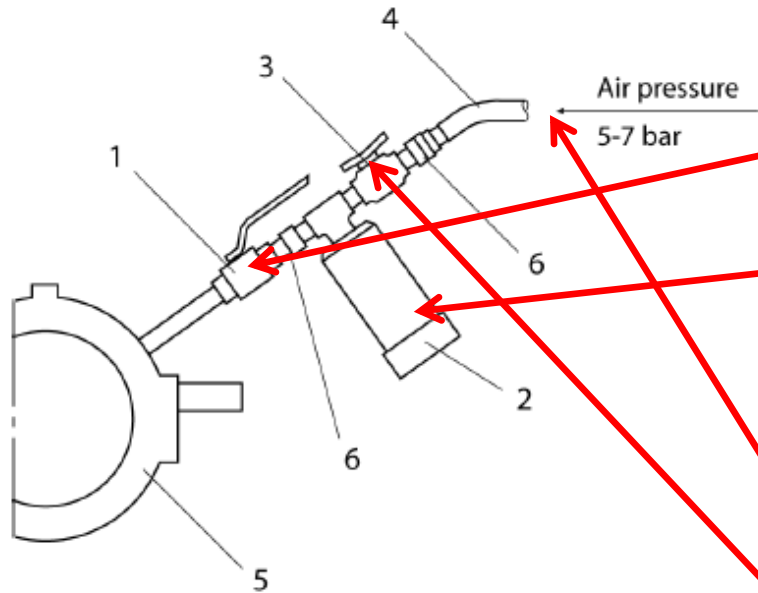


- Cleaning in- service by the dry-or wet-cleaning method is performed by injection of a measured amount of granulate or water into the gas or compressor pipe of the turbine.



- The injection of the granulate is done by means of working air at a pressure of app. 5-7 bar.
- The cleaning effect is similar to that of water washing i.e. a mechanical effect arising from the impact of the cleaning medium of the turbine components.

The cleaning is carried out during high engine load minimum 75 % at full load.



- |   |               |   |                   |
|---|---------------|---|-------------------|
| 1 | Closing valve | 2 | Container         |
| 3 | Air valve     | 4 | working air inlet |
| 5 | Exhaust pipe  | 6 | Snap coupling     |

Before connecting the "blow-gun" open the closing valve (1), and check whether there is free passage.

Fill cleaning granulated substance into the container (2) for turbocharger type:

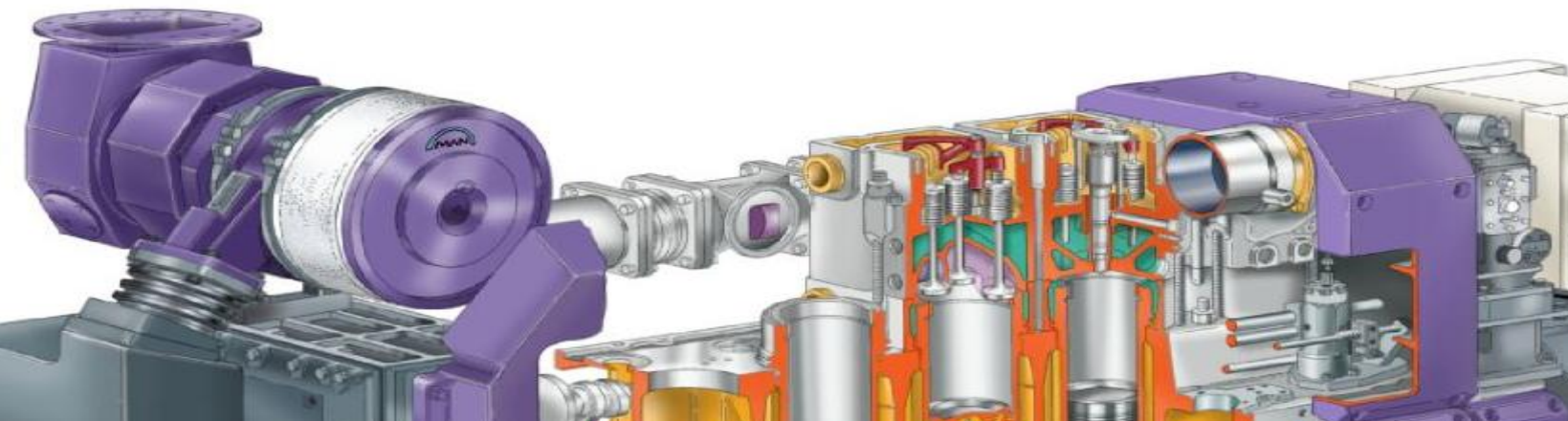
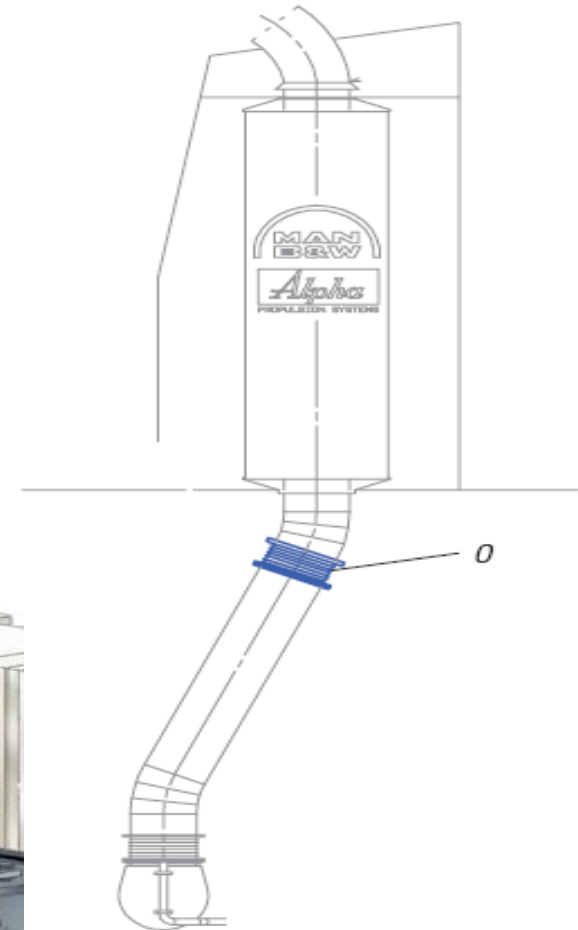
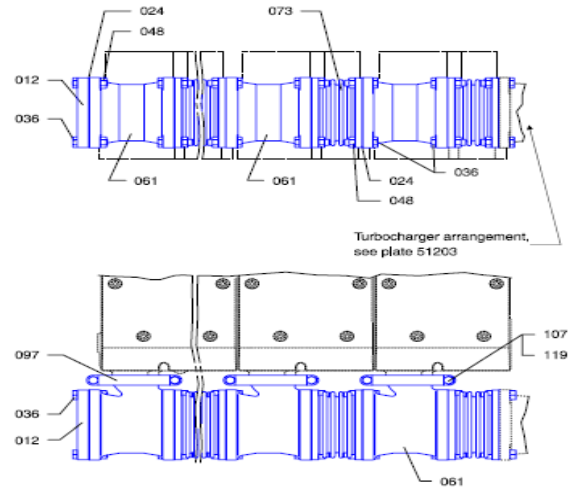
- NR20/R - NR20/S 0.2 - 0.3 liters
- NR24/R - NR26/R 0.3 - 0.4 liters

Connect to the working air system (4), 5 -7 bar.

Connect the "blow-gun" to valve (1). Open air valve (3).

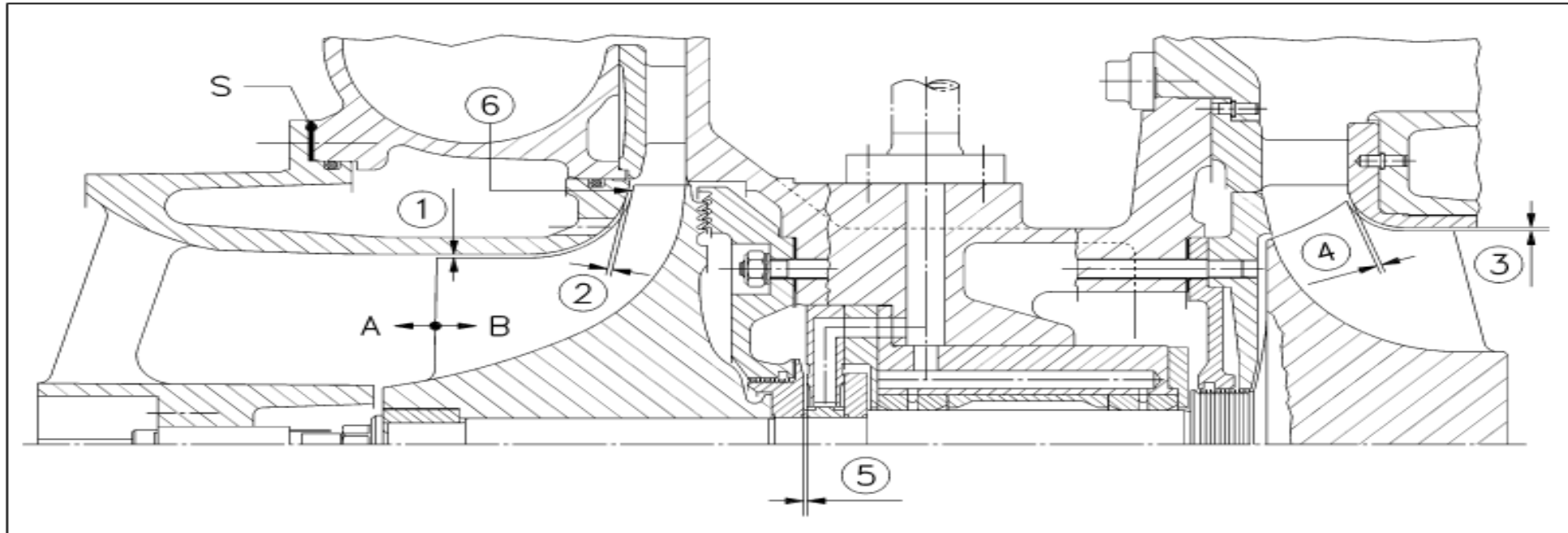
Then open valve (1) slowly until a whistling sound indicates that blowing-in takes place. Injection time app. 2 min.

# Turbo charger exhaust system



# Turbo charger system

## NR 24 Gaps and clearance

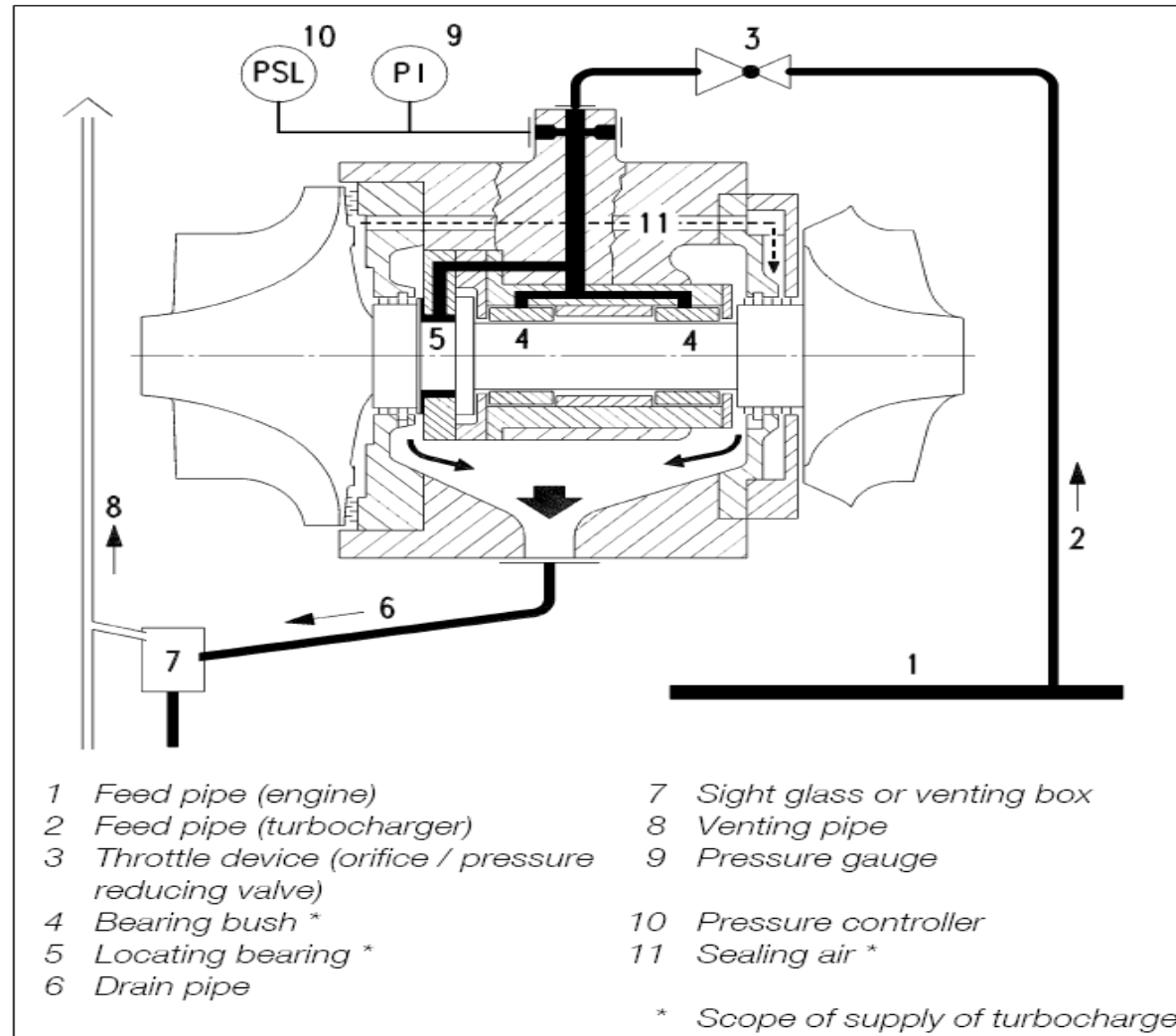


Item	Designations of parts	Order No.		When new		Replace or remachine parts	
				min. in mm	max. in mm	min. in mm	max. in mm
1	a) Compressor wheel Insert	(520.005) (540.001)	Radial gap	0.60	0.70	0.50	0.90
2	b) Compressor wheel Insert	(520.005) (540.001)	Axial gap	0.15	0.70	0.10	0.80
3	a) Turbine rotor Insert	(520.001) (541.001)	Radial gap	0.60	0.70	0.50	0.90
4	d) Turbine rotor Insert	(520.001) (541.001)	Axial gap	0.40	1.00	---	1.10
5	e) Locating bearing Labyrinth ring	(517.002) (520.006)	Axial clearance	0.19	0.21	---	0.29
6	Compressor wheel	(520.005)		Permissible axial runout 0.06			

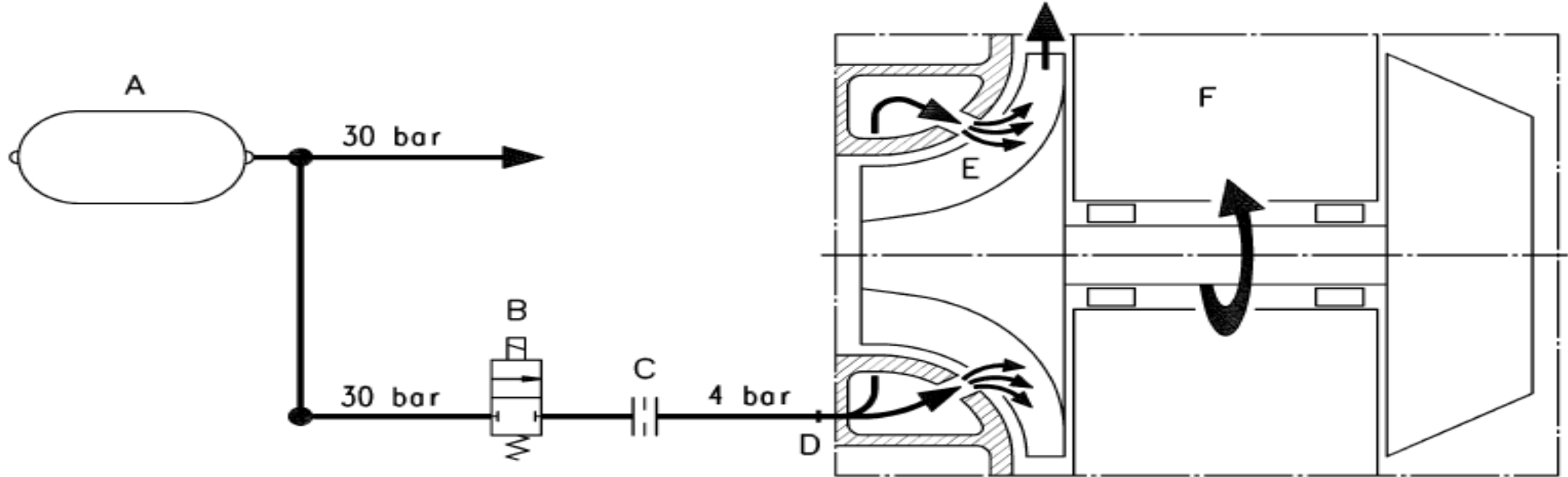


# NR/S Turbo charger system

## NR 24 maintenace Lub.oil system



# NR/S Turbo charger system NR Jet assist



- A Starting air cylinder (30 bar)
- B 2/2 way solenoid valve
- C Orifice
- D Insert
- E Compressor wheel
- F Turbocharger

# NR/S Turbo charger system NR jet assist



With out Jet assist







With Jet assist

# NR/S Turbo charger system

## NR Maintenance symbols



1, 2, 3	Serial number of the maintenance work. The series shows gaps for changes/up-dates which could become necessary.
	Brief description of the job
	Related work cards. The work cards listed contain detailed information on the work steps required. A No Work card required/available
x ↔ y	Relation between working cards. These notes are of particular significance within the maintenance system CoCoS. They give you information on the jobs with a temporal connection to the work in question.
	Required personnel
	Time required in hours per person
per	Relational term to indicate the time required
24 ... 18,000 24 ... 30,000	Repetition intervals given in operating hours 24 ... 18,000 (NR) 24 ... 18,000 (NA, at the four-stroke engine) 24 ... 30,000 (NA, at the two-stroke engine)
X, 1, 2	Signs used in the columns of intervals. Their meaning is repeated in each sheet. We assume that the signs and symbols used in the head are sufficiently pictorial and that it is not necessary to repeat them constantly.

# NR/S Turbo charger system

## NR Maintenance service report



1, 2, 3					per	24	150	250	3000	6000	12000
<b>Inspection (during operation)</b>											
901	Check turbocharger for unusual noise and vibrations.	A	1	0,1	Turbo	X					
903	Check turbocharger and system pipes for leaks (sealing air, charge air, exhaust gas, lube oil)	A	1	0,2	Turbo	X					
905	Check all the fixing screws, casing screws and pipe connections for tight fit	500.10	1	1	Turbo			2	X		
<b>Maintenance (during operation)</b>											
911	Clean turbine - Dry cleaning, if provided	500.07	1	0,3	Turbo	1					
913	Clean turbine - Wet cleaning, if provided	500.07	1	0,6	Turbo		1				
915	Clean compressor (during operation)	500.08	1	0,3	Turbo		1				
917	Clean air filter (if provided)	500.11	1	0,4	Turbo			1			
<b>Maintenance (together with engine maintenance)</b>											
931	Clean and check compressor casing, insert, diffuser and compressor wheel (visual inspection). Establish operational readiness of the turbocharger again.	500.10 500.14	2	4	Turbo					X	
951	Major overhaul 12,000 ... 18,000 operating hours: Dismantle, clean and check all components of the turbocharger. Check gaps and clearances upon assembly	000.31 500.06 500.10 500.16 500.24 500.27	2	20	Turbo						X



### Maintenance Schedule, Legend

24 ... 12000

Repetition intervals in operating hours

X Maintenance work due

1 As required/depending on condition

2 Check new or overhauled parts once after the time specified

# NR/S Turbo charger system

## NR Maintenance service report



**Relating to service report of** ..... Date .....  
 Name of customer ..... Turbocharger .....  
 Address ..... Works No. ....  
 Site ..... Engine type .....  
 Ship's name ..... Works No.. ....  
 Turbocharger inspected / overhauled on ..... by .....  
 Reason .....  
 Last inspection / overhaul on ..... by .....  
 No. of operating hours since last inspection / overhaul ..... h  
 No. of operating hours since commissioning ..... h

**Air intake casing**, if provided  
 fouled  
 by .....  
**Silencer**, if provided  
 air filter mat  
 replaced  
 reason: .....  
 felt linings  
 fouled  
 wavy  
 separated  
**Speed transmitter**, if provided  
 defective  
 pole plates deformed  
**Speed indicator**, if provided  
 defective  
**Insert on compressor side**  
 used  replaced  
 fouled  
 by .....  
 signs of touching  
 radial  
 over the entire circumference  
 in sections of the circumference

**Compressor casing**  
 fouled  
 by .....  
 cracks  
 damage by foreign object  
**Diffuser**  
 used  replaced  
 fouled  
 by .....  
 vanes bent  
 vanes with incipient cracks  
 damage by foreign object  
**Compressor wheel**  
 fouled  
 by .....  
 signs of touching  
 axial  
 radial  
 over the entire circumference  
 in sections of circumference  
 blades  
 bent  
 with cracks  
 damage by foreign object  
 bore  
 fretting corrosion

**Turbine rotor**  
 fouled  
 by .....  
 signs of touching  
 radial  
 over the entire circumference  
 in sections of circumference  
 blades  
 bent  
 with cracks  
 erosion  
 damage by foreign objects  
 bearing points  
 fretting marks  
 wear  
 seating faces  
 fretting corrosion  
 labyrinth tips  
 oil coke  
 wear  
**Labyrinth ring**  
 used  replaced  
 fretting marks  
 wear  
 fretting corrosion

**Thrust ring**  
 used  replaced  
 fretting marks  
 wear  
 fretting corrosion  
**Bearing casing**  
 fouled  
 by .....  
 cracks  
 sealing air bores  
 clogged  cleaned  
 oil bore  
 clogged  cleaned  
 seals  
 replaced  
**Locating bearing**  
 used  replaced  
 fretting marks  
 wear  
 axial face, compressor side  
 axial face, turbine side  
 inside diameter  
**Bearing bush** compressor side  
 used  replaced  
 fretting marks  
 wear  
 outside diameter  
 inside diameter  
 please tick the appropriate box

**Bearing bush** turbine side  
 used  replaced  
 fretting marks  
 wear  
 outside diameter  
 inside diameter  
**Sealing cover** compressor side  
 used  replaced  
 abnormal running-in pattern  
 wear  
 signs of touching  
**Sealing cover** turbine side  
 used  replaced  
 abnormal running-in pattern  
 wear  
 oil coke  cleaned  
**Cover disc**  
 used  replaced  
 wear  
 oil coke  cleaned  
**Turbine nozzle ring**  
 used  replaced  
 vanes bent  
 vanes with incipient cracks  
 damage by foreign object  
 erosion

**Insert** turbine side  
 used  replaced  
 fouled  
 erosion  
 signs of touching  
 over the entire circumference  
 in section of the circumference  
**Gas-admission casing**  
 fouled  
 by .....  
 cracks  
 erosion  
 damage by foreign object  
 screwed connections  
 slack  
 torn off  
 replaced  
**Gas outlet casing**  
 fouled  
 by .....  
 cracks  
 damage by foreign object  
 screwed connections  
 slack  
 torn off  
 replaced

**Gaps and clearances**, (for admissible values refer to sheet 2.5.5)  
 Item 1 Compressor wheel / insert (radial gap) ..... mm  
 Item 2 Compressor wheel / insert (axial gap) ..... mm  
 Item 3 Turbine rotor / insert (radial gap) ..... mm  
 Item 4 Turbine rotor / insert (axial gap) ..... mm  
 Item 5 Locating bearing / labyrinth ring (axial clearance) ..... mm  
 Item 6 Face runout, compressor wheel ..... mm  
**Remarks:** .....

# NR/S Turbo charger system

## NR Maintenance service report



**Service Report**  
**Turbocharger NR/S**

Author:					
Customer:					
Plant/vessel:					
Turbocharger type:		Engine type:			
Turbocharger work No.:		Engine work No.:			

Compressor wheel, gap (1)  
before maintenance  
after maintenance

Turbine rotor, gap (3)  
before maintenance  
after maintenance

maintenance	2	5	1		Turbine rotor COC-No.	Compressor wheel COC-No.
before	---					
after						

Remarks:

Date \_\_\_\_\_ Chief Inspector \_\_\_\_\_ Service Engineer \_\_\_\_\_

# NR/S Turbo charger system

## NR Maintenance Torque values



Screw connections should be tightened by means of torque wrenches as far as possible.

For important screw connections on the turbocharger, the tightening torques are prescribed in the relevant work cards.

For all the other screw connections, which are tightened using a torque wrench, guide values for the tightening torques are stated in table 2.

The following should be observed:

- The load acting on a screw connection depends on the tightening torque applied, on the lubricant used, the finished condition of the surfaces and threads, and on the materials paired. It is, therefore, of great importance that all these conditions are met.
- Table 2 lists the tightening torques for various threads as a function of the coefficient of friction, i.e. of the lubricant used. The torques are based on bolt material of the strength class 8.8 with the bolts stressed up to approximately 70 % of the elastic limit. For other strength classes, the tightening torques listed in the table have to be multiplied by the corresponding conversion factors. The strength class is stamped on the bolt head.

Strength class	5.6	6.8	10.9	12.9
Conversion factor x	0.47	0.75	1.40	1.70

Table 1. Conversion factors for tightening torques as a function of the bolt strength class

Approximate coefficient of friction  $\mu$  :

$\mu = 0.08$  with lubricants, for temperatures  
 $\leq 200^{\circ}\text{C}$ , e.g. Molykote G-n or Molykote P40  
 $\geq 200^{\circ}\text{C}$ , e.g. Molykote HSC

$\mu = 0.14$  for surfaces that are not finish-treated, with a thin film of oil



# NR/S Turbo charger system

## NR Maintenance Torque values



Thread Nominal size	Tightening torque in Nm Coefficient of friction $\mu$		Thread Nominal size	Tightening torque in Nm Coefficient of friction $\mu$	
	0.08	0.14		0.08	0.14
M 5	4	6	M 24	475	690
M 6	7	10	M 24x2	500	750
M 8	17	25	M 27	700	1020
M 10	34	50	M 27x2	730	1100
M 12	60	85	M 30	950	1380
M 14	95	135	M 30x2	1015	1540
M 14x1.5	100	145	M 33	1270	1870
M 16	140	205	M 33x2	1350	2060
M 16x1.5	150	220	M 36	1640	2400
M 18	200	280	M 36x3	1710	2550
M 18x1.5	215	320	M 39	2115	3120
M 18x2	205	300	M 39x3	2190	3300
M 20	275	400	M 42	2630	3860
M 20x1.5	295	450	M 42x3	2760	4170
M 20x2	285	425	M 45	3260	4820
M 22	370	540	M 45x3	3415	5180
M 22x1.5	395	595	M 48	3950	5820
M 22x2	380	565	M 48x3	4185	6370

# NR/S Turbo charger system

## NR List of assemblies



D

GB

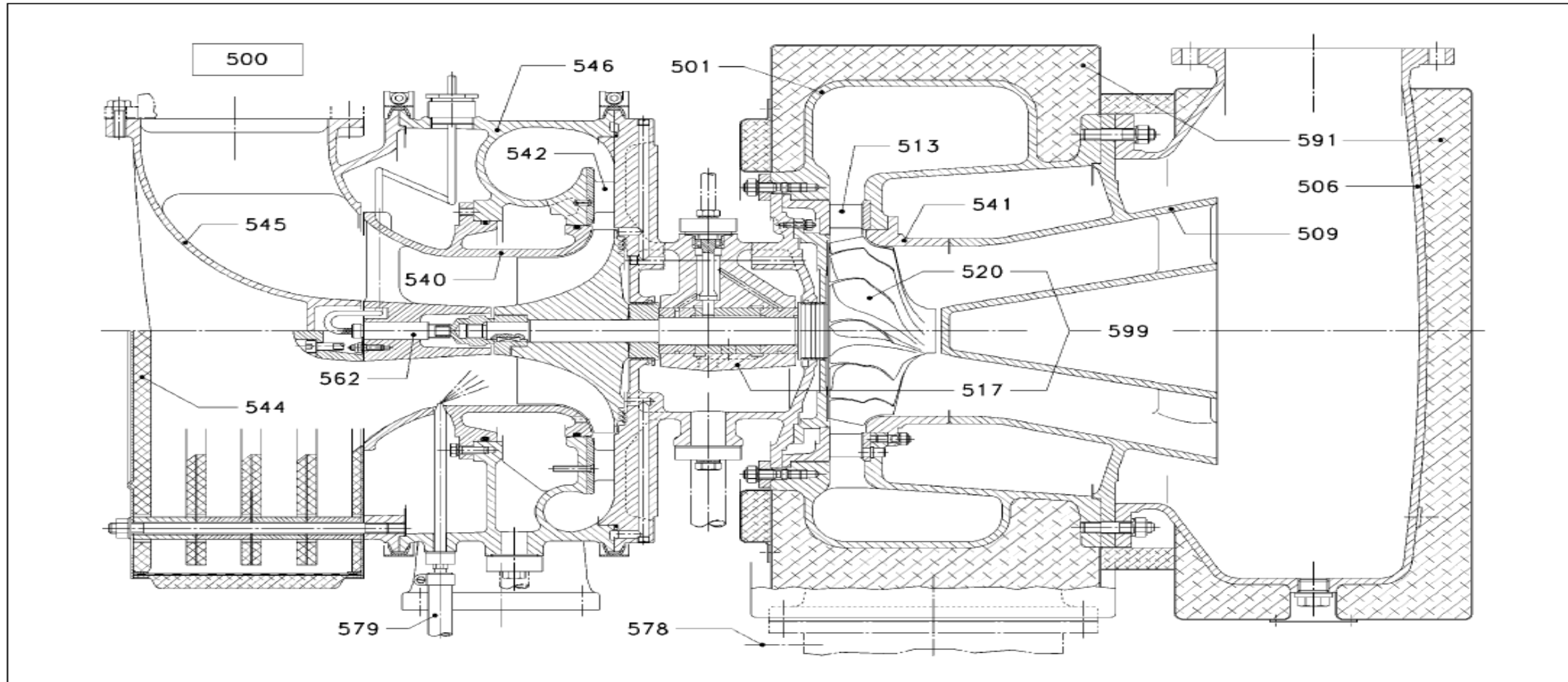
F

E

500	Abgasturbolader	Exhaust gas turbocharger	Turbocompresseur à gaz d'échappement	Turbosobrealimentador de gas de escape
501	Turbinen-Zuströmgehäuse	Gas-admission casing	Corps d'admission de turbine	Carcasa de afluencia de la turbina
506	Turbinen-Abströmgehäuse	Gas outlet casing	Corps d'échappement de turbine	Carcasa de evacuación de la turbina
509	Turbinen-Abströmdiffusor	Gas outlet diffuser	Diffuseur d'échappement de turbine	Difusor de evacuación de la turbina
513	Turbinenleitapparat	Turbine nozzle ring	Distributeur de turbine	Distribuidor de gases de la turbina
517	Lagergehäuse	Bearing casing	Boîte de paliers	Carcasa de cojinetes
520	Läufer komplett	Rotor complete	Rotor complet	Rotor completo
540	Einsatzstück, verdichterseitig	Insert, compressor side	Insert, côté compresseur	Pieza de inserción, lado del compresor
541	Einsatzstück, turbinenseitig	Insert, turbine side	Insert, côté turbine	Pieza de inserción, lado de la turbina
542	Nachleitapparat	Diffuser	Diffuseur	Difusor
(544)	Schalldämpfer	Silencer	Silencieux	Silenciador
(545)	Ansauggehäuse	Air intake casing	Corps d'aspiration	Caja de aspiración
546	Verdichtergehäuse	Compressor casing	Corps de compresseur	Caja del compresor
(562)	Drehzahlmeßeinrichtung	Speed measuring device	Dispositif de mesure de régime	Instalación para la medición del número de revoluciones
(578)	Reinigungseinrichtung für Turbine	Cleaning device for turbine	Dispositif de nettoyage pour turbine	Dispositivo de lavado para turbina
(579)	Reinigungseinrichtung für Verdichter	Cleaning device for compressor	Dispositif de nettoyage pour compresseur	Dispositivo de lavado para compresor
(591)	Verschaltungen	Coverings	Revêtements	Revestimientos

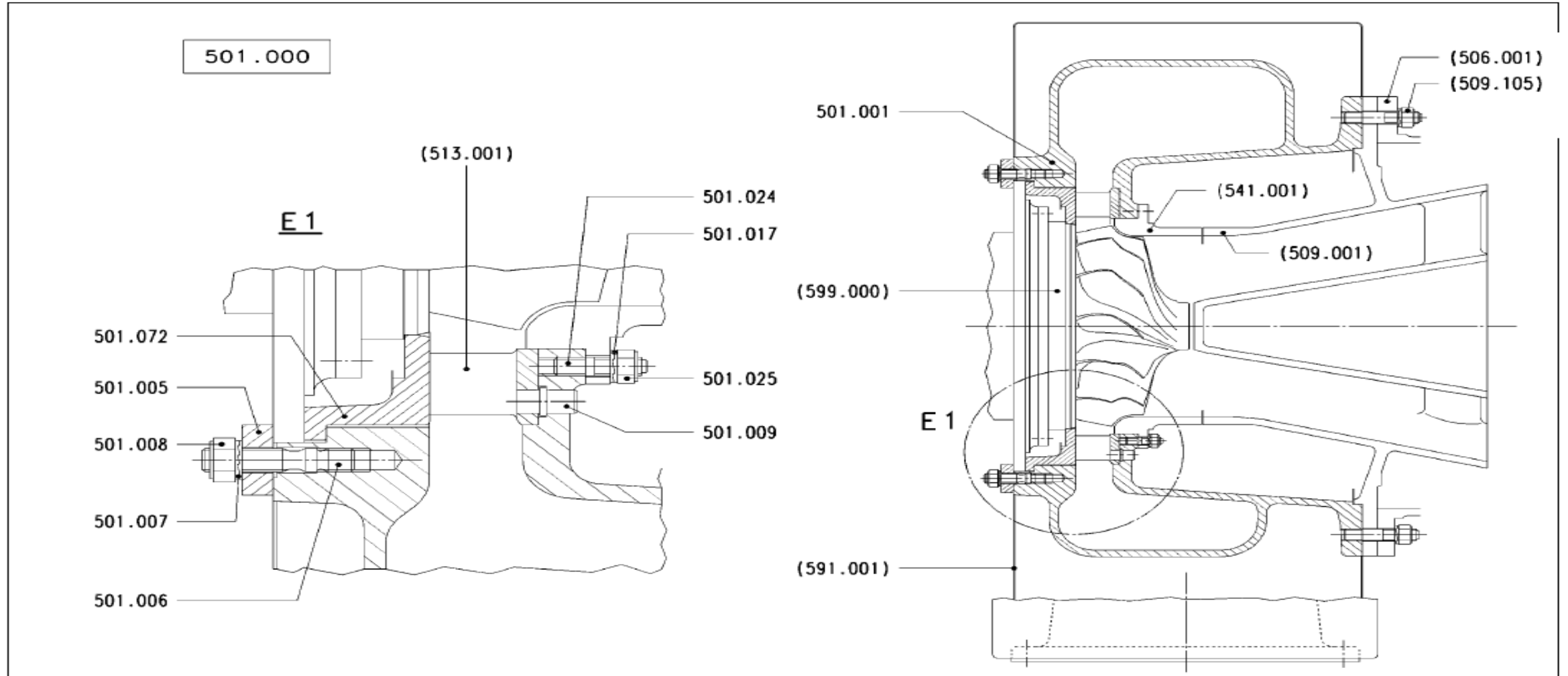
# NR/S Turbo charger system

## NR List of assemblies



# NR/S Turbo charger system

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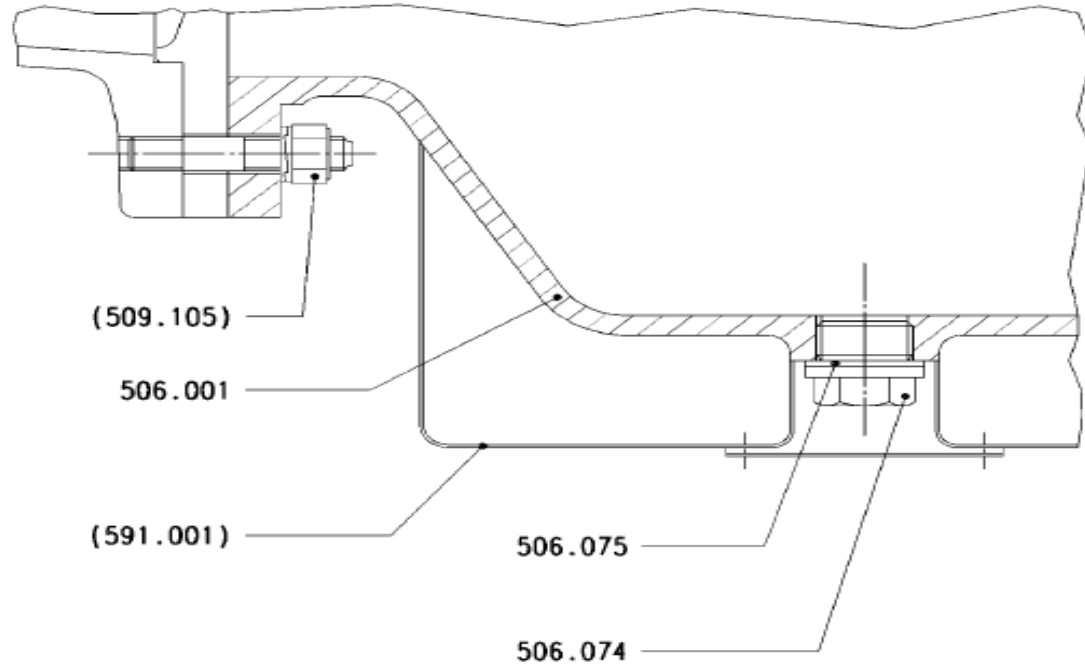
# NR/S Turbo charger system

## NR List of assemblies



506.000

E 1



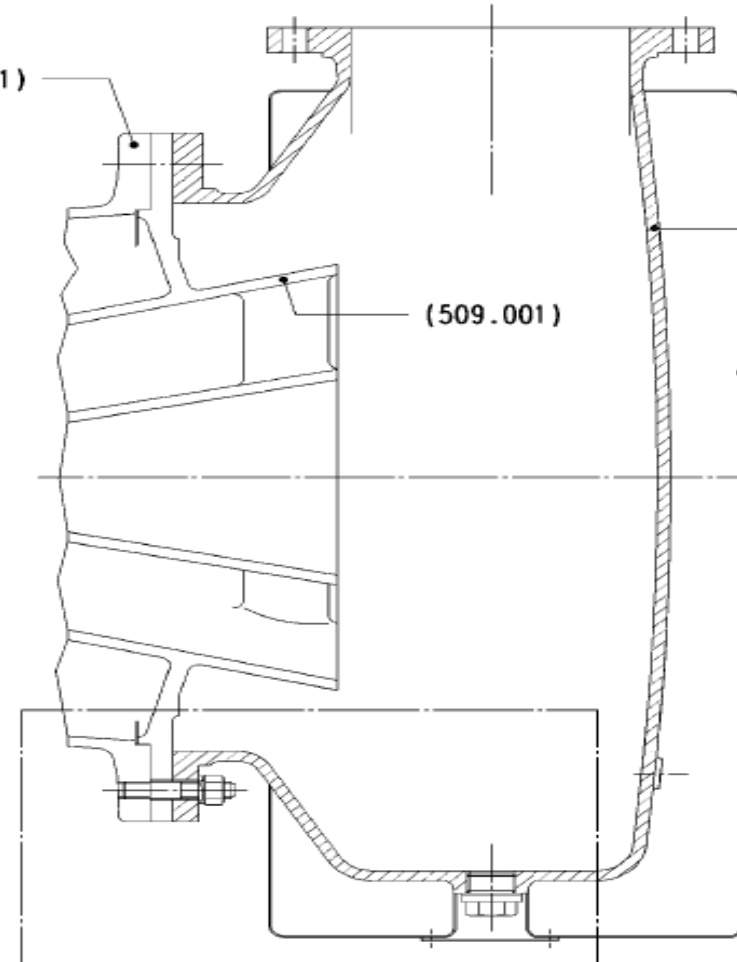
(501.001)

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506.001

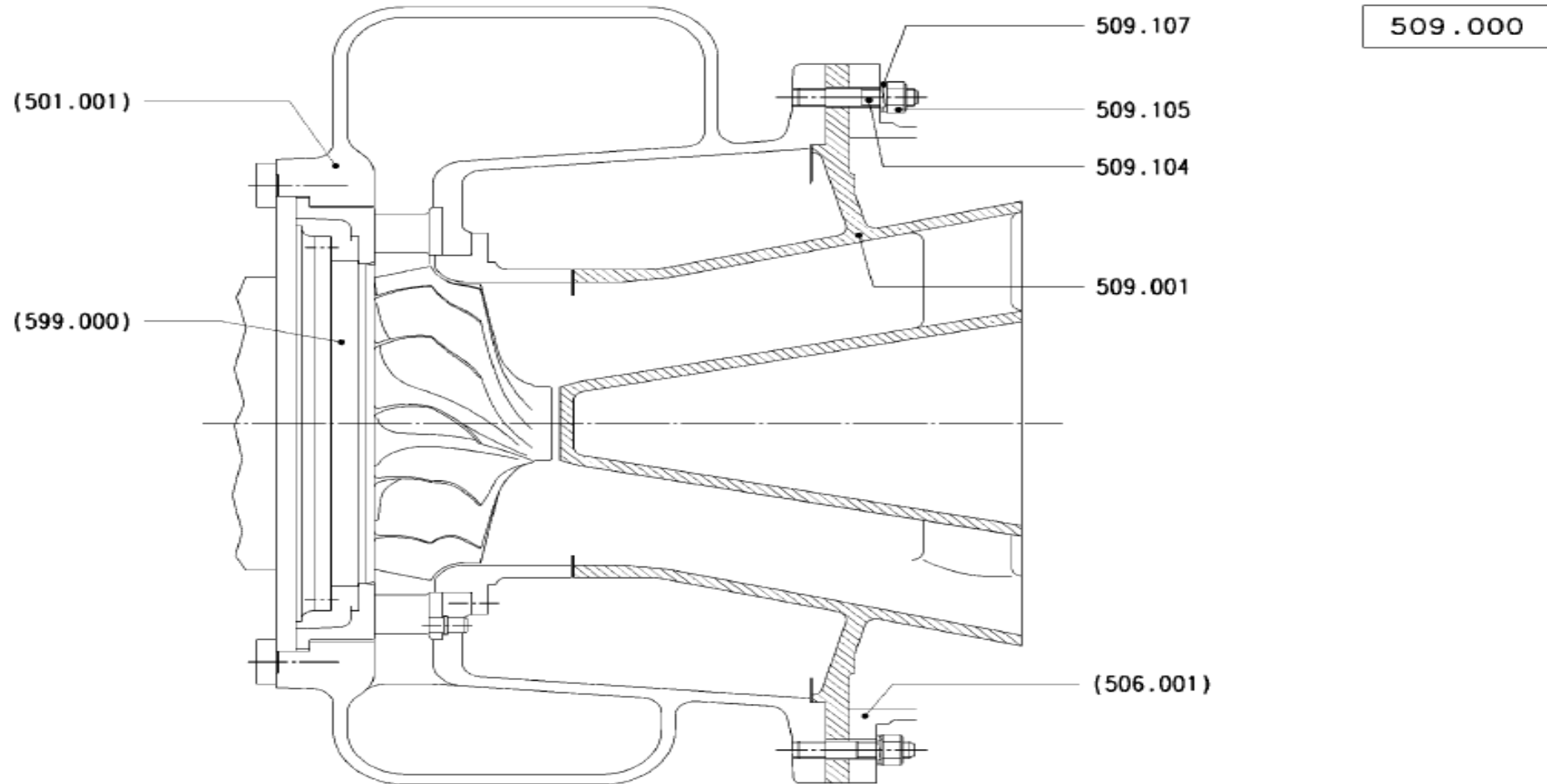
(591.101)

E 1



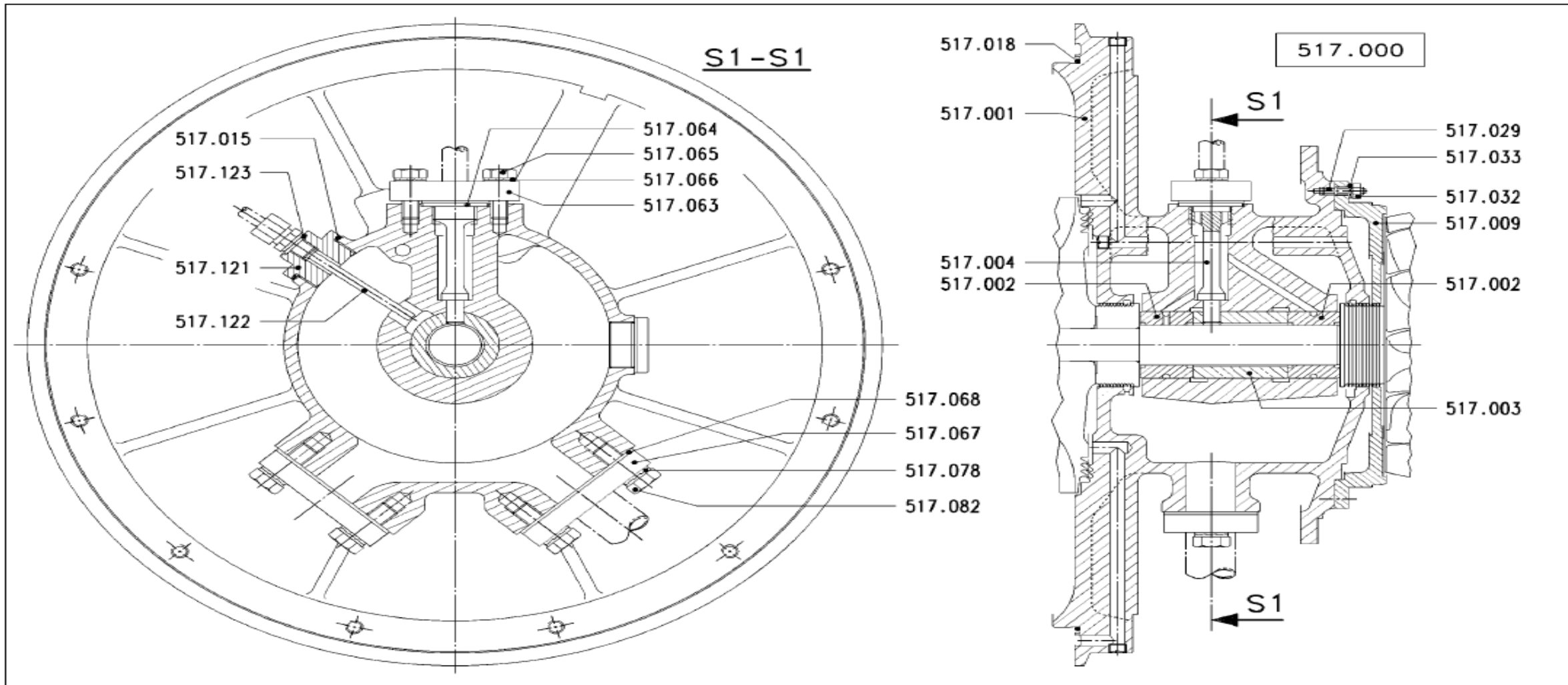
# NR/S Turbo charger system

## NR List of assemblies



# NR/S Turbo charger system

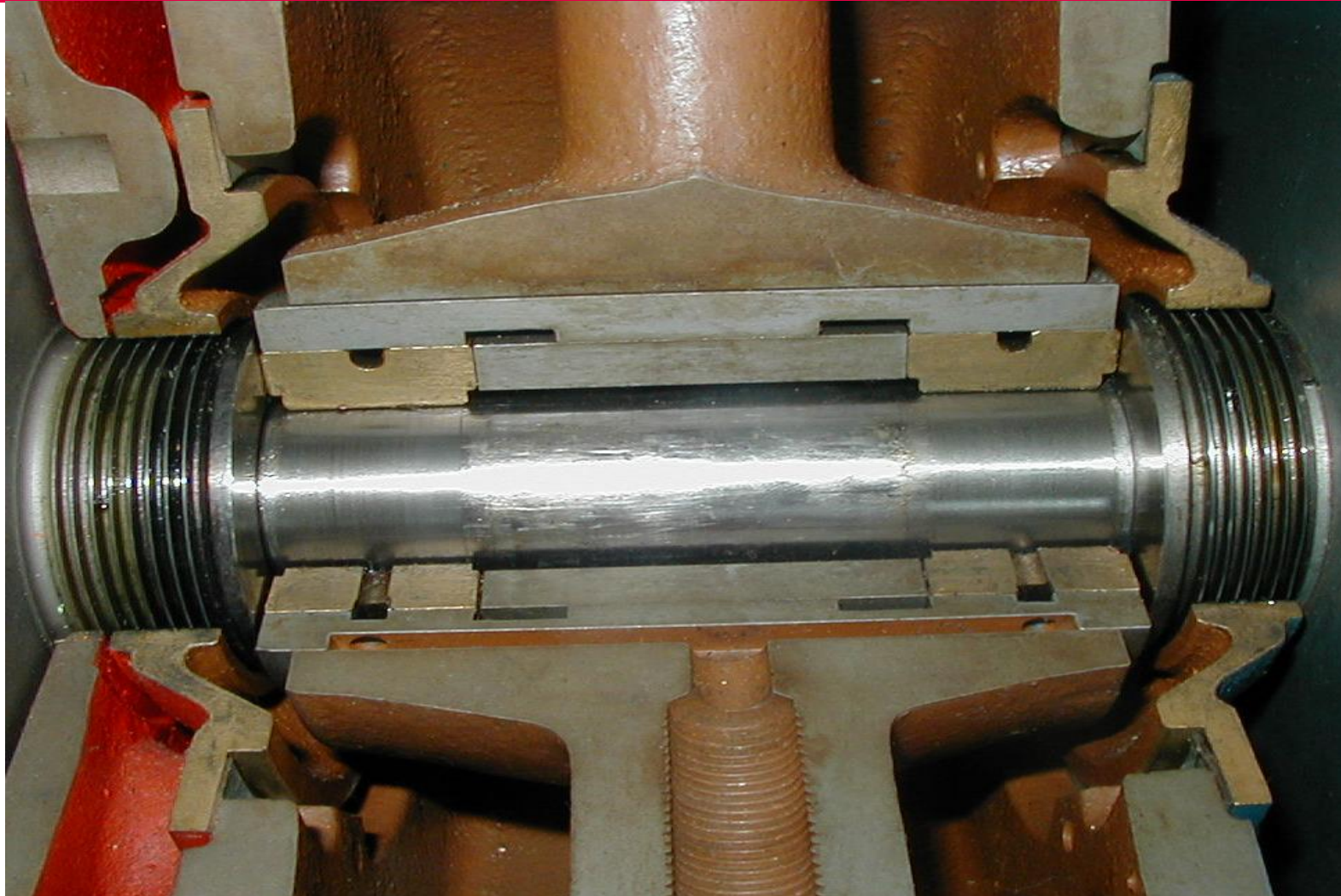
## NR List of assemblies





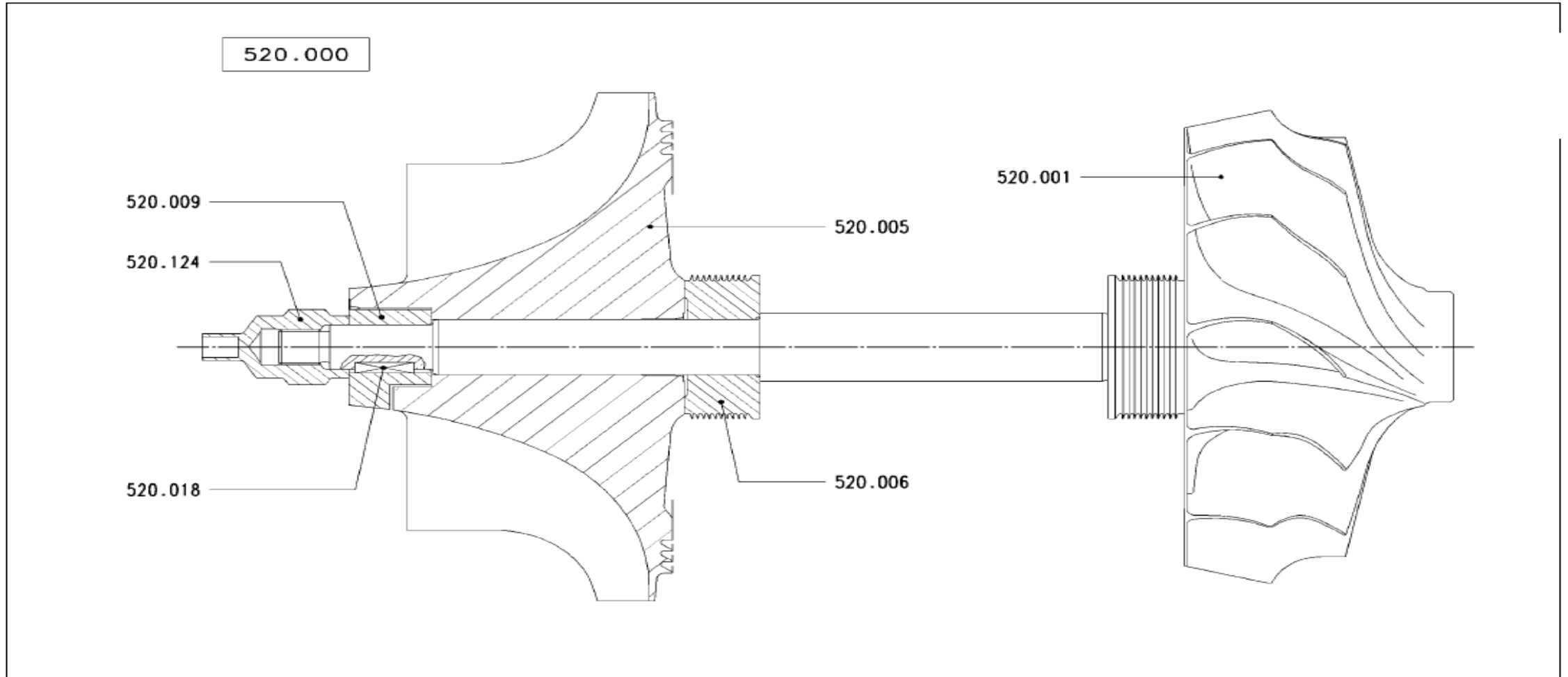
# NR/S Turbo charger system

## NR Cartridge



# NR/S Turbo charger system

## NR complete rotor

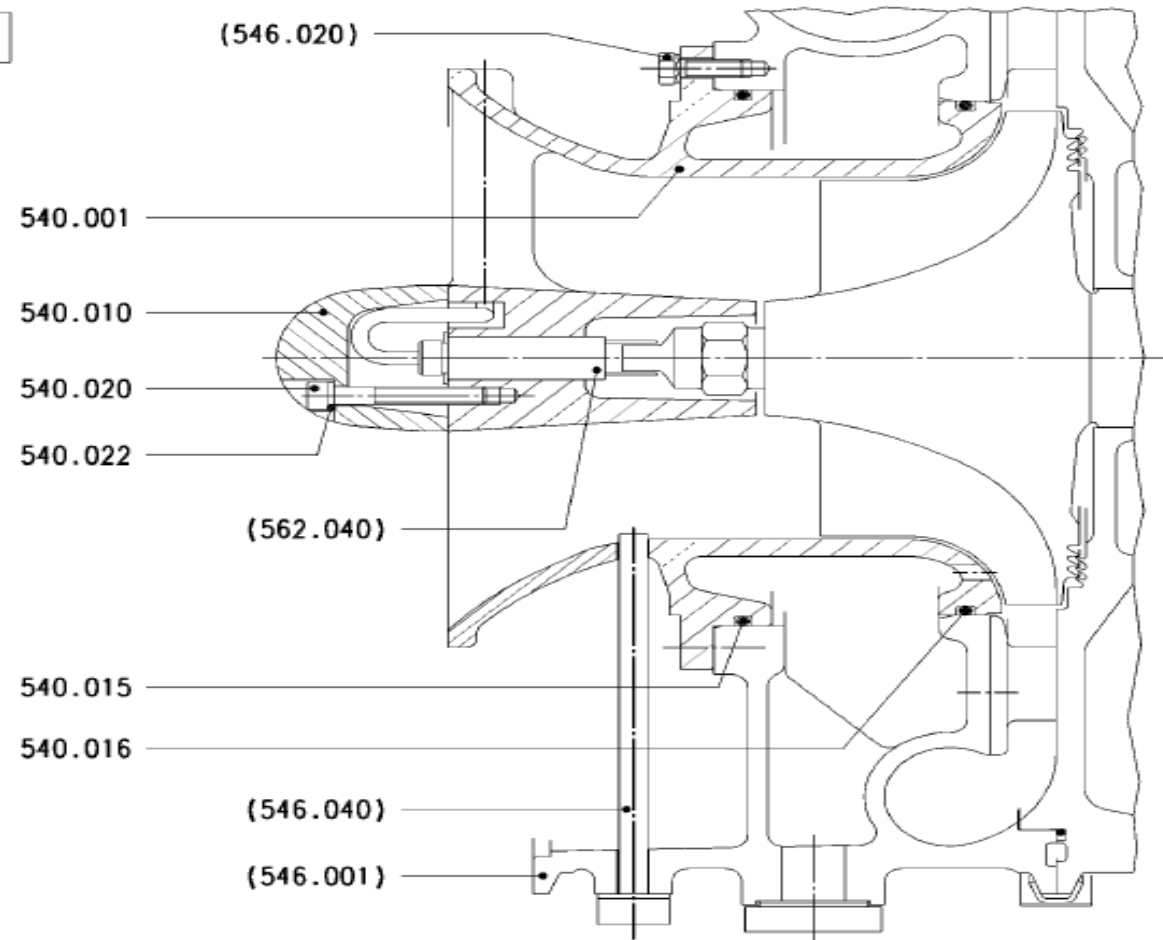


# NR/S Turbo charger system

## NR Insert

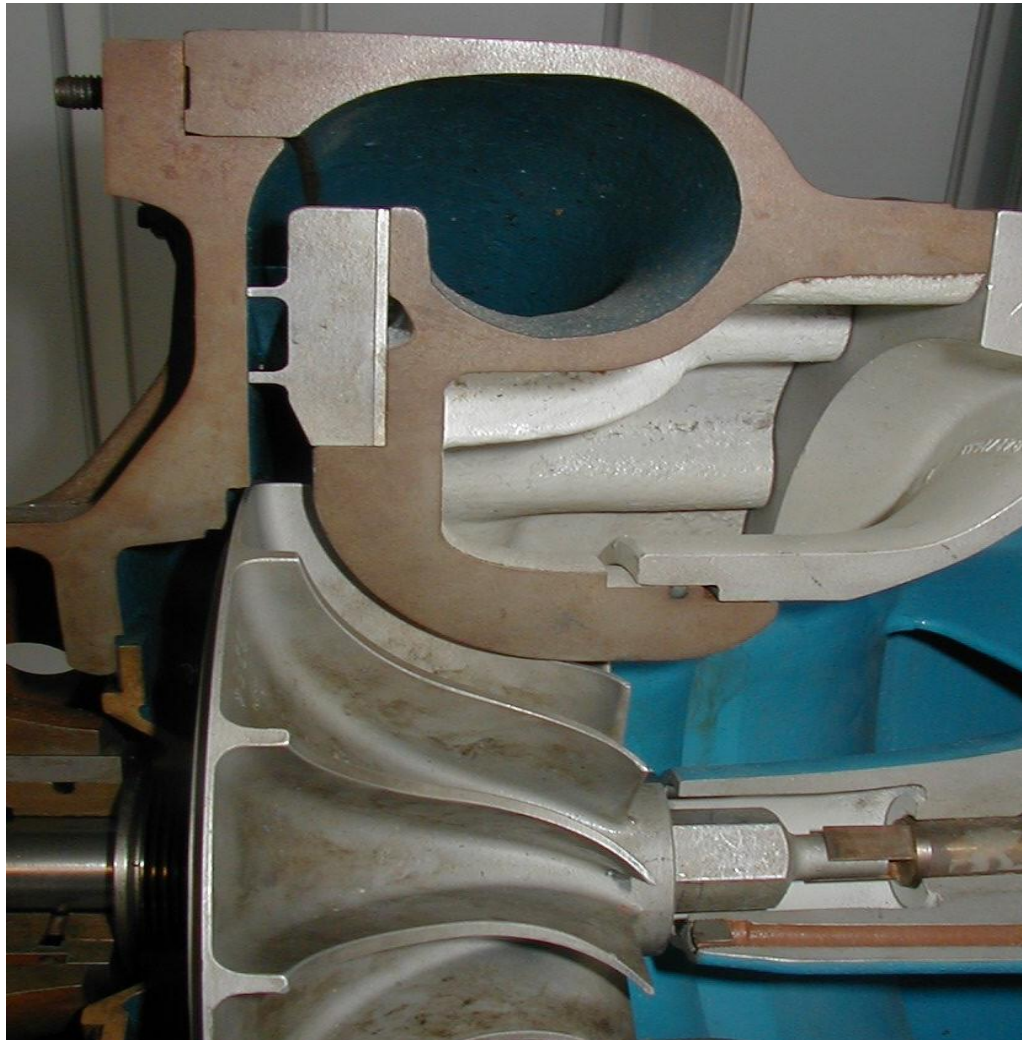


540.000



# NR/S Turbo charger system

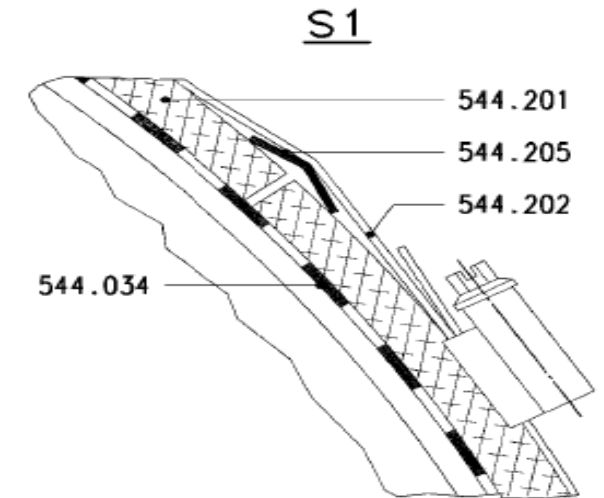
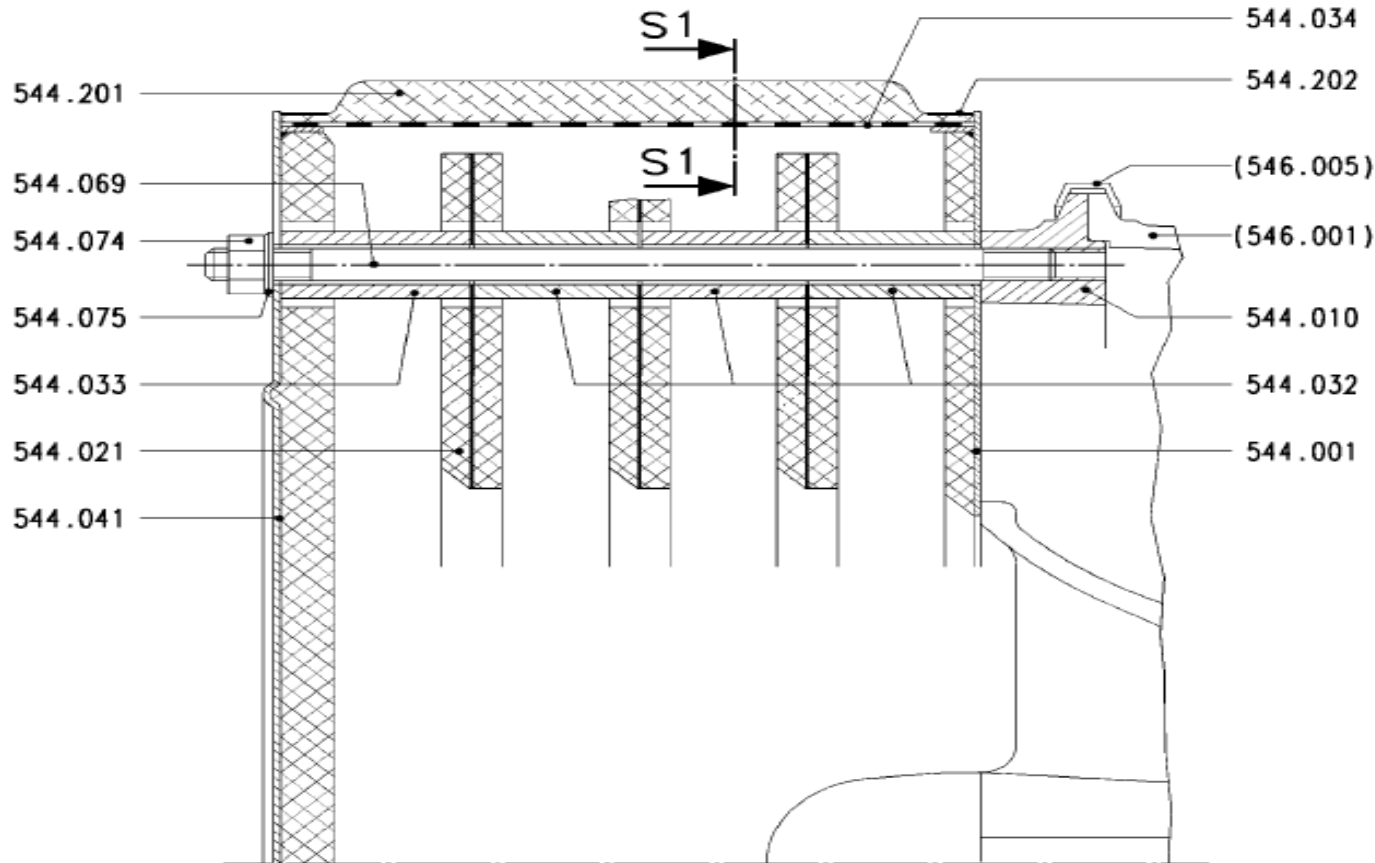
## Compressor side



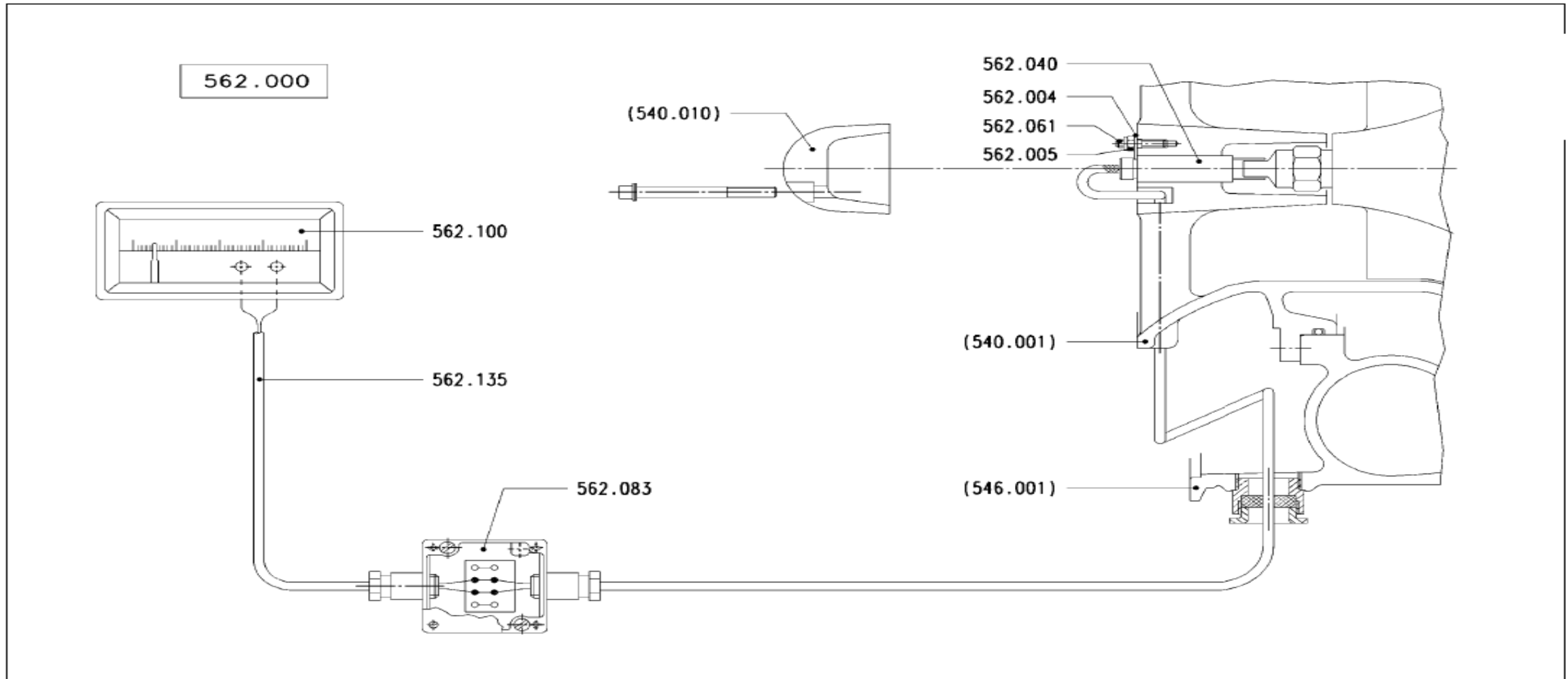
# NR/S Turbo charger system Silencer



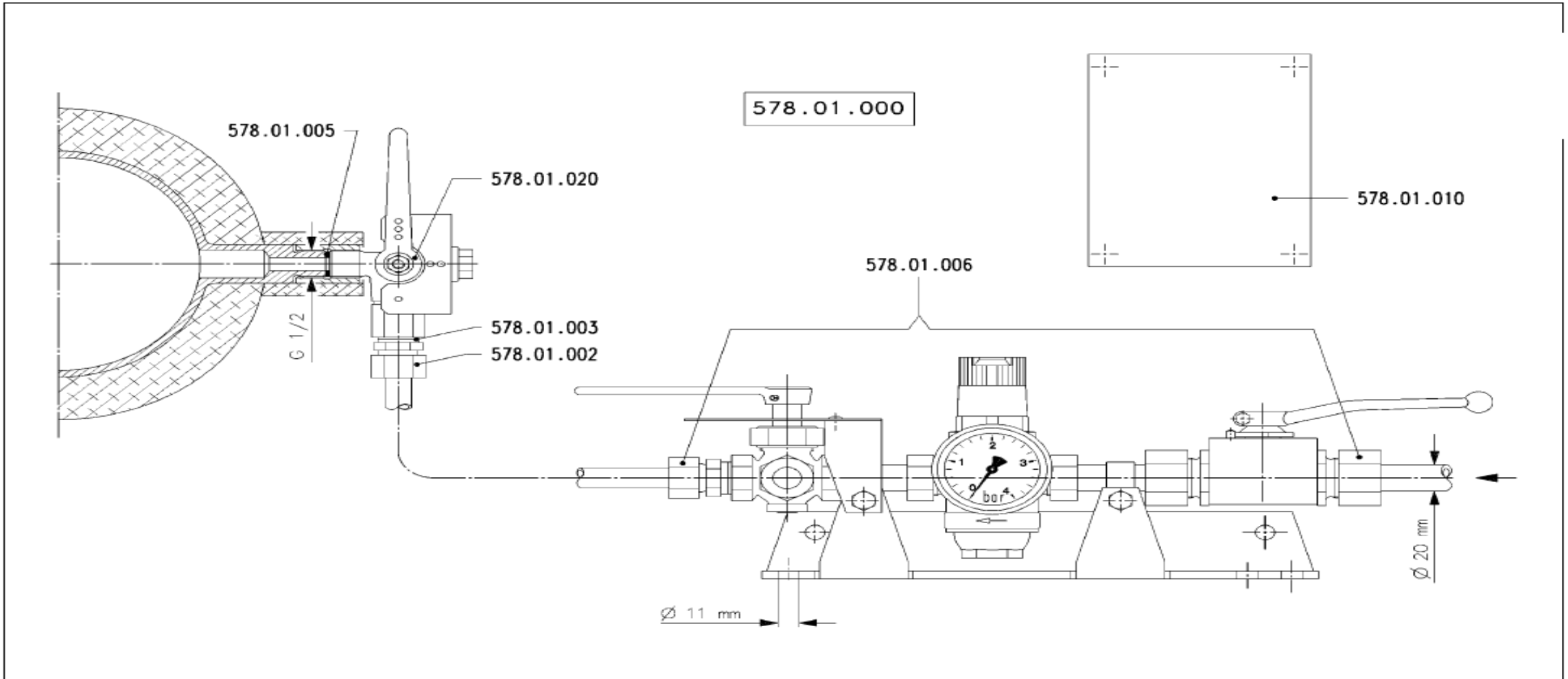
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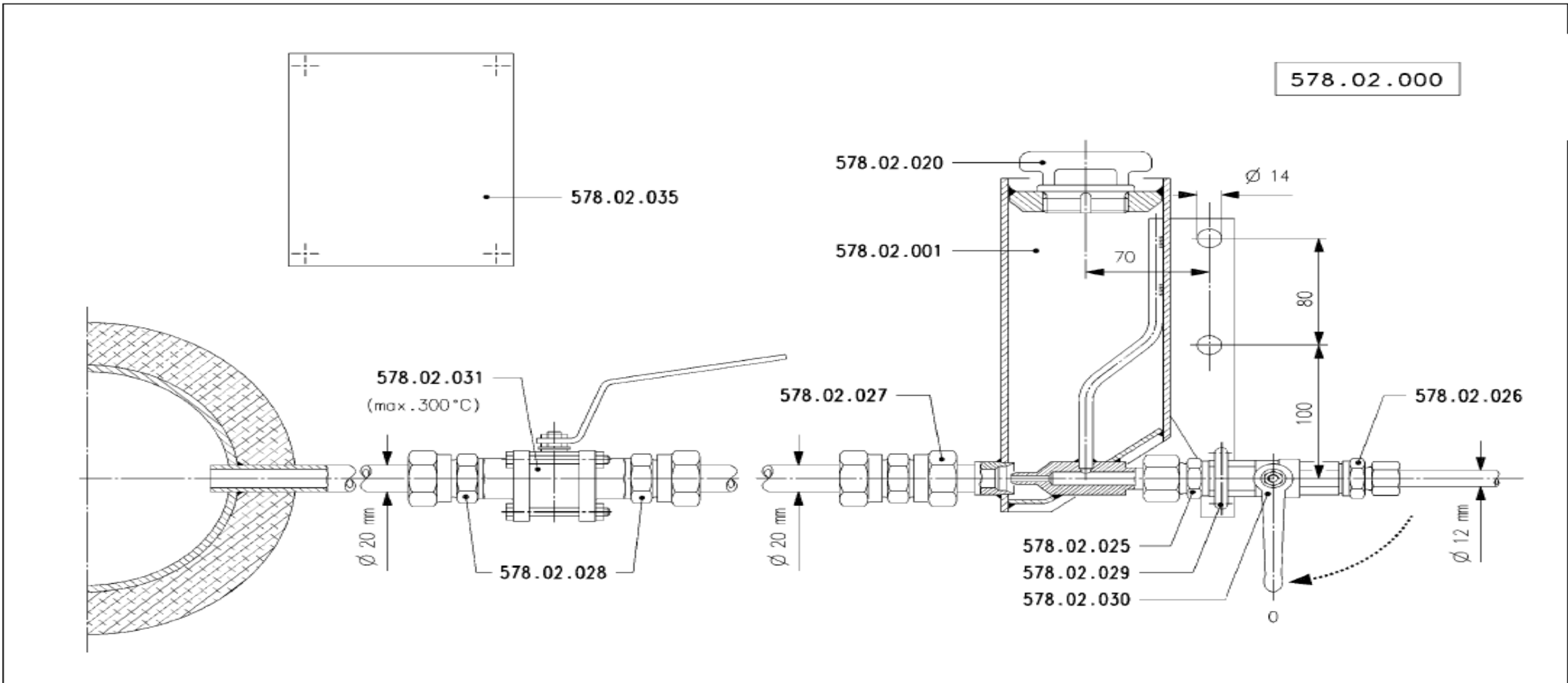
# NR/STurbo charger system Speed sensor



# NR/S Turbo charger system Cleaning device turbine side



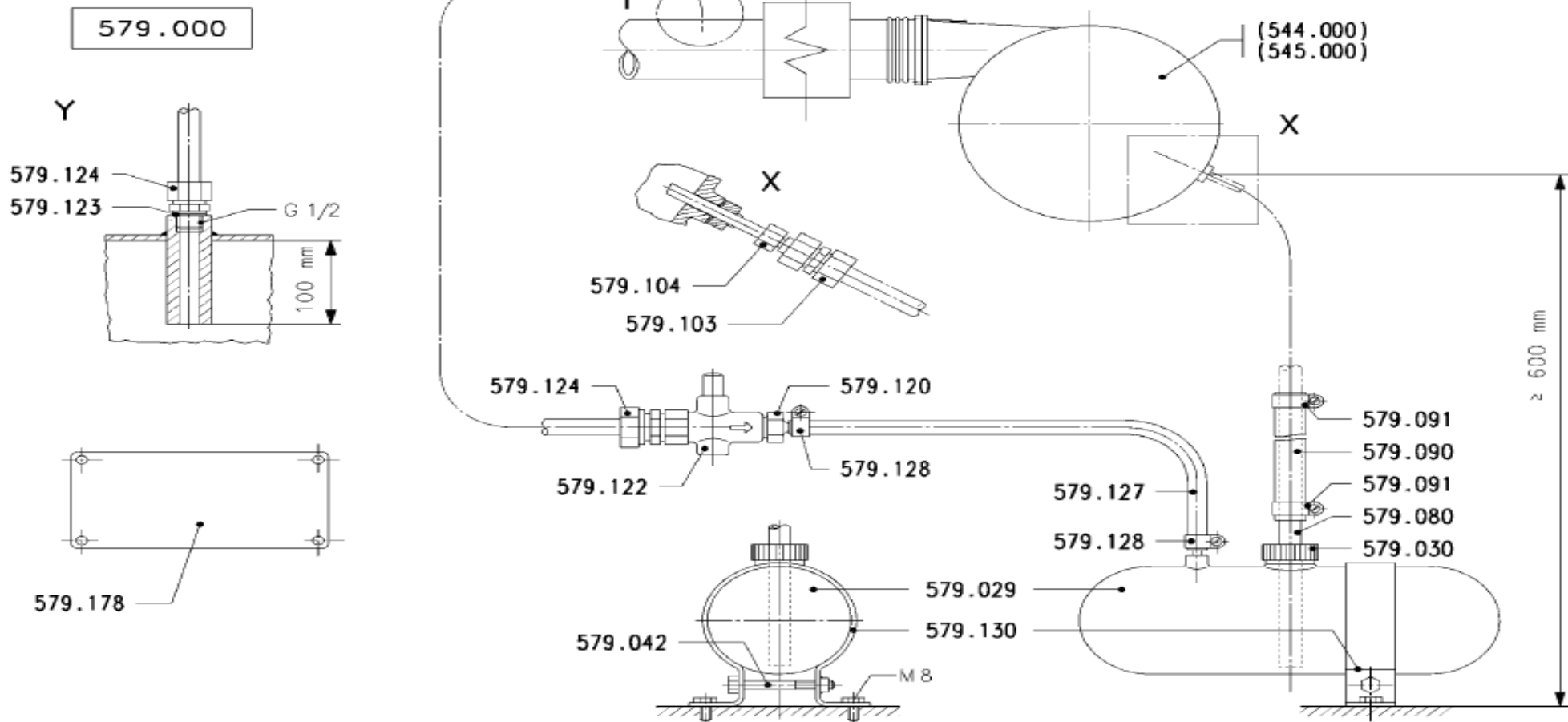
# NR/S Turbo charger system Cleaning device for turbine II



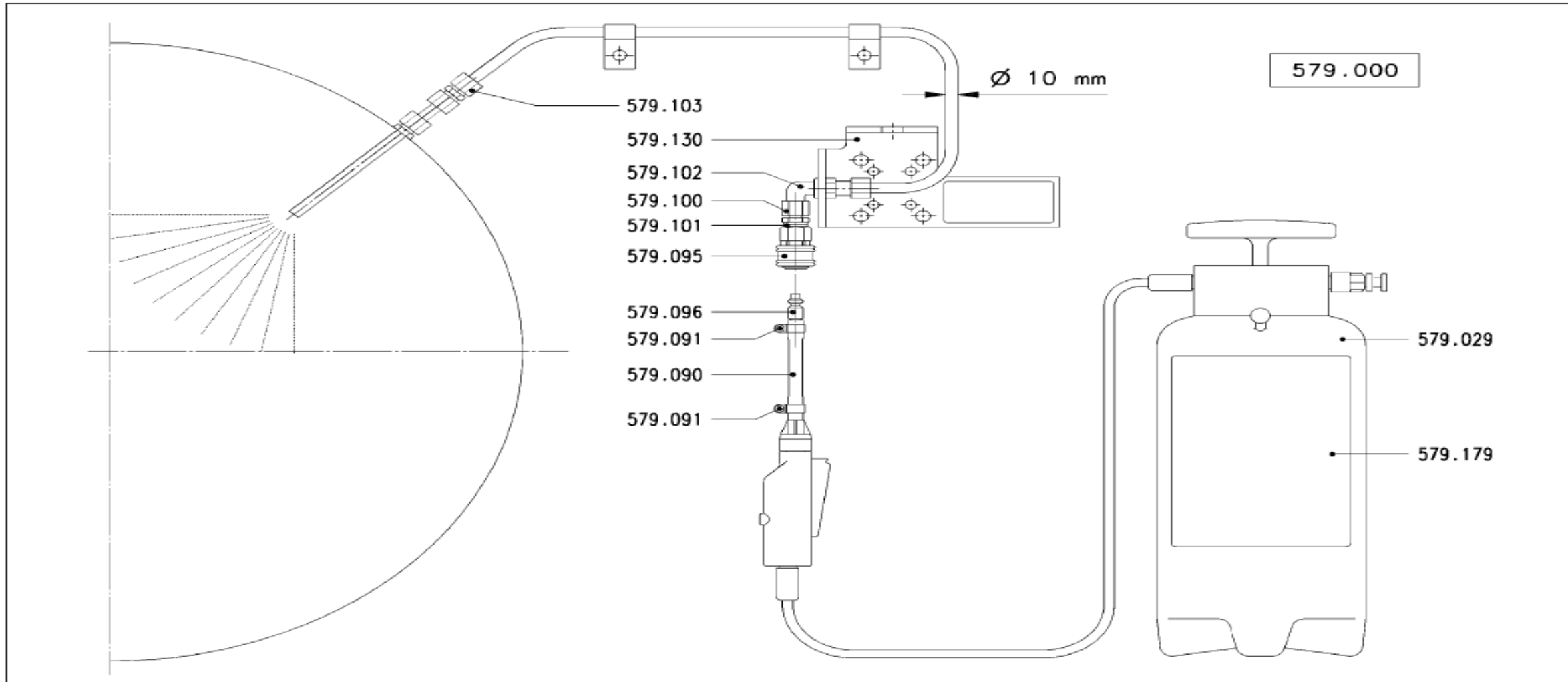


# NR/S Turbo charger system

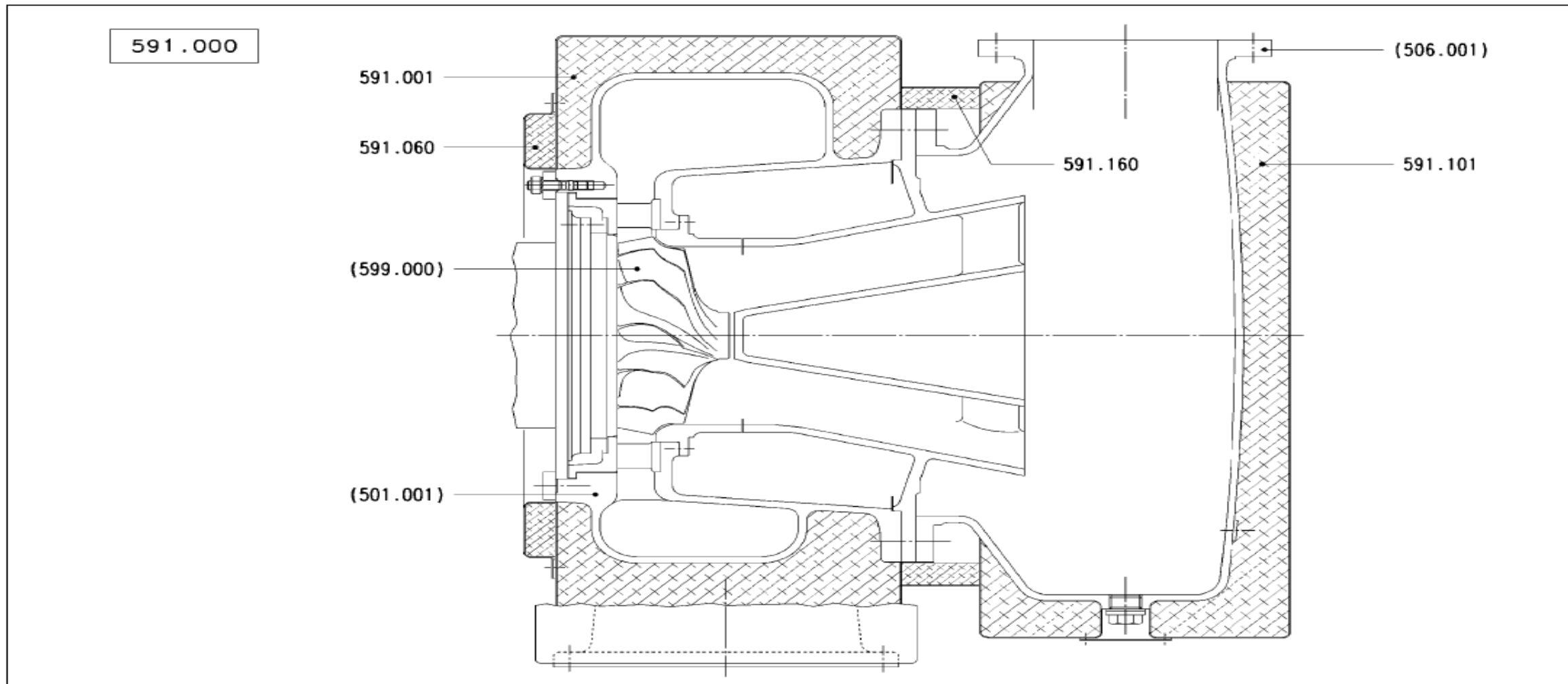
## Cleaning device compressor side



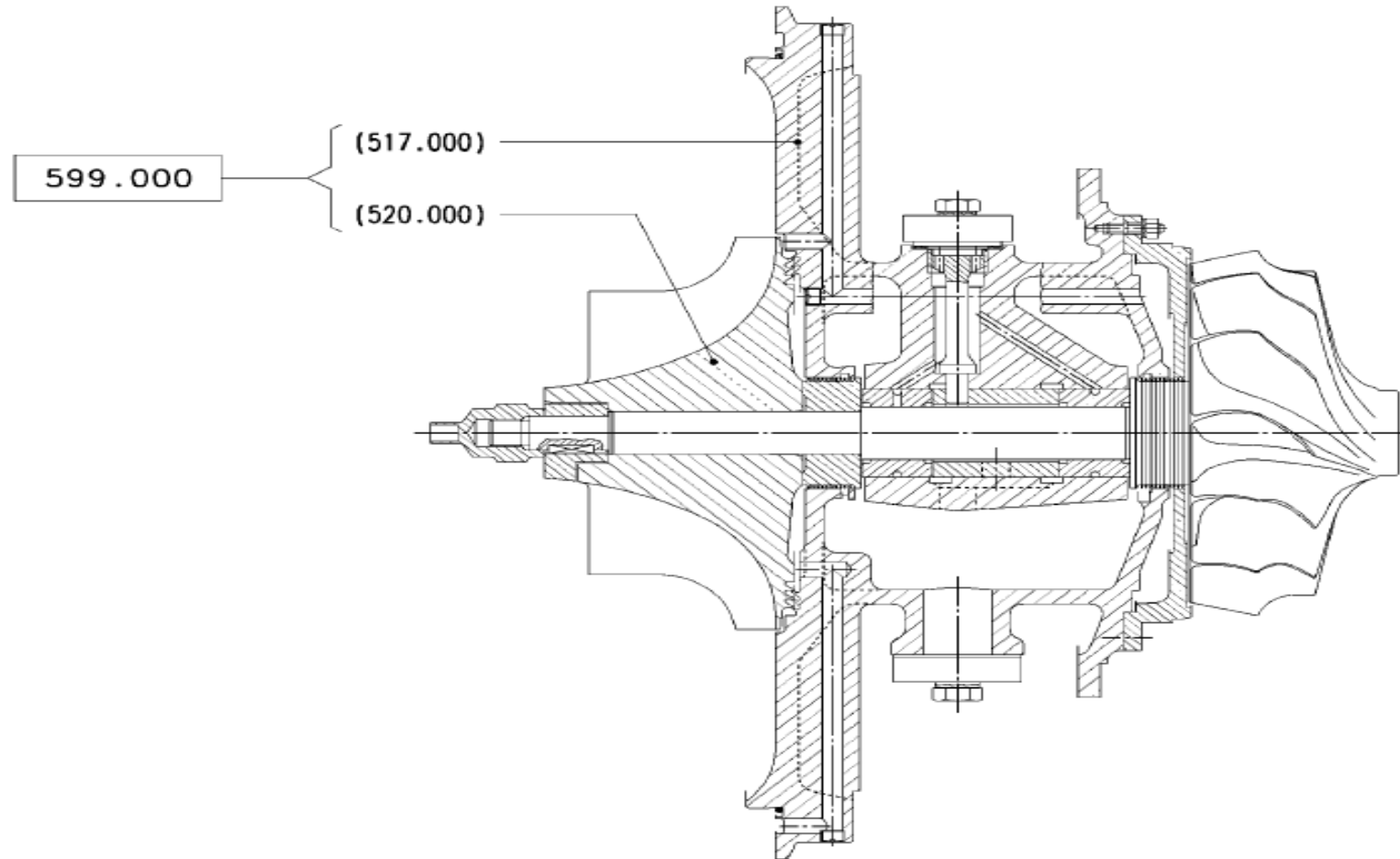
# NR/S Turbo charger system Cleaning device compressor side



# NR/S Turbo charger system Covering



# NR/S Turbo charger system Cartridge



# Disclaimer



All data provided in this document is non-binding.

This data serves informational purposes only and is especially not guaranteed in any way. Depending on the subsequent specific individual projects, the relevant data may be subject to changes and will be assessed and determined individually for each project. This will depend on the particular characteristics of each individual project, especially specific site and operational conditions.

# Do you have any more questions?



**Joe Bloggs**

[Contact details]

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[Contact details]