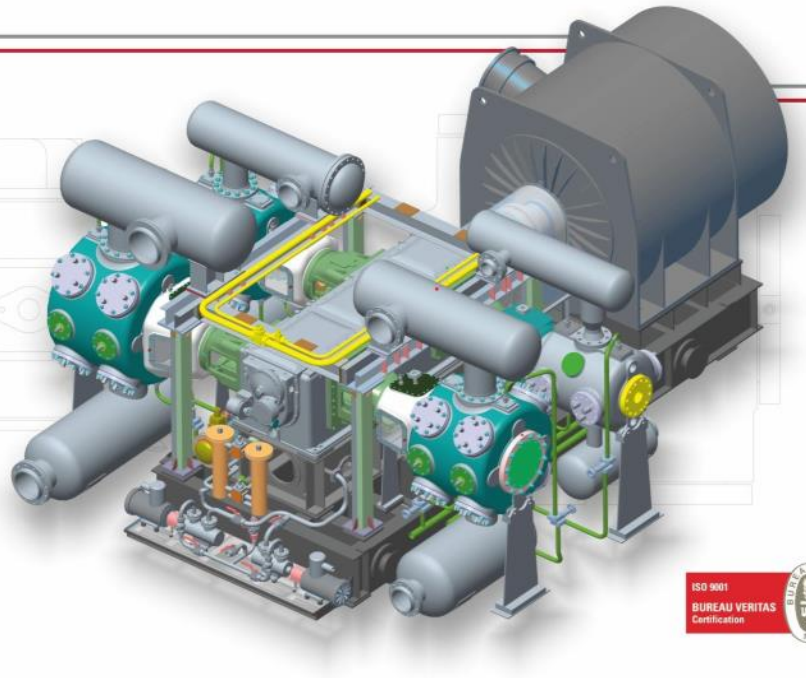
FRUNZE

RECIPROCATING COMPRESSORS

"SMNPO - Engineering" JSC

*Technical Catalogue*

# RECIPROCATING COMPRESSORS

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# 1 About the Company “SMNPO - Engineering” JSC

“SMNPO - Engineering” JSC is now one of the largest machine-building enterprises in Europe manufacturing equipment and developing complex solutions for oil, gas, chemical, petrochemical and power industries.

Company products and services include the following:

- compressor equipment and gas pumping units;
- full range of process equipment for gas compressor stations;
- general-purpose industrial pumps and electric pump units;
- pumps and electric pump units for nuclear power plants;
- heat-exchange and mass-transfer equipment, pressure vessels and tanks;
- process units for cleaning, processing, treatment and primary conditioning of natural gas and crude; complete oil and gas industry facilities and complete chemical and petrochemical production lines;
- facilities on EPC terms;
- installation, supervision over installation, pre-commissioning, designer's supervision, training of Customer's personnel;
- spare parts supply, modernization and replacement of equipment;
- engineering.

Unique manufacturing and testing complex together with advanced scientific and technological potential and human resources of the Company enables to solve non-standard tasks in terms well ahead of traditional ones. Products quality is ensured by means of quality control system at all production stages in accordance with international standard ISO 9001. Designing, production and testing of finished products are performed in compliance with domestic (GOST, Ukr SEPRO) as well as recognized international standards (API, ASME, ISO, EN).

# Content

# 3 Introductory part

"SMNPO - Engineering" JSC is one of the oldest enterprises in manufacturing of heavy duty reciprocating compressors.

The first super power compressor with capacity of 10 000 $m^3$/hour for pressure of 300 atmosphere was manufactured by the company in 1933 for Bereznikovsky chemical plant. In 1949 the first heavy duty horizontal compressor 1G-166/320 was produced. Reciprocating compressors of high and super-high pressure are used for the production of mineral fertilizers, for production of polyethylene under high pressure, compression of natural and associated petroleum gas, air, nitrogen, hydrogen, in the petrochemical and metallurgical industries.

The specialists of the company have mastered the production of a number of general-purpose compressors, unique compressors for hydrogen-containing gas compressing in the oil refining industry, fuel gas for power plants, for complete facilities when compressing associated petroleum and natural gas, compressors for locking end gas-dynamic seals of centrifugal compressor units. The company focuses on the production of high-speed reciprocating compressors, which makes it possible to create reciprocating gas-compressor units driven by gas-piston engines.

All compressors are equipped with a system of automatic control and protection, which ensures control of basic operating parameters, emergency warning and alarms and shutdown of prime movers.

Depending on the requirements of the customer, the equipment is manufactured for various parameters of capacity and power, final pressure and compression ratio. Possessing a powerful production and scientific and technical potential, the enterprise can execute the development of drawings as soon as possible, produce, test and deliver the required equipment to the customer, perform its installation, commissioning and, if necessary, provide its servicing.

# 4 Main Types of Reciprocating Compressors

| No. | Base designation | Number of rows | Maximum reciprocating force, t | Maximum shaft rotational speed, rpm | Type of bearings | Catalogue page No. |
|---|---|---|---|---|---|---|
| 1 | 2GM2.5 | 2 | 2.5 | 1000 | roller | 10 |
| 2 | 4GM2.5 | 4 | 2.5 | 1000 | roller | 11 |
| 3 | 2GM4 | 2 | 4.0 | 750 | sliding | 12 |
| 4 | 2GM10 | 2 | 10.0 | 600 | sliding | 13 |
| 5 | 4GM10 | 4 | 10.0 | 600 | sliding | 14 |
| 6 | 2GM10A | 2 | 10.0 | 1000 | sliding | 15 |
| 7 | 2GM16 | 2 | 16.0 | 375 | sliding | 16 |
| 8 | 4GM16 | 4 | 16.0 | 375 | sliding | 17 |
| 9 | 6GM16 | 6 | 16.0 | 375 | sliding | 18 |
| 10 | 4GM25 | 4 | 25.0 | 375 | sliding | 19 |
| 11 | 6GM25 | 6 | 25.0 | 375 | sliding | 20 |
| 12 | 6GM25A | 6 | 25.0 | 1000 | sliding | 21 |
| 13 | 4GM40 | 4 | 40.0 | 300 | sliding | 22 |
| 14 | 6GM40 | 6 | 40.0 | 300 | sliding | 23 |
| 15 | GT1 | 1 | 1.0 | 1000 | roller | 24 |
| 16 | 2GT1.6 | 2 | 1.6 | 1000 | roller | 25 |
| 17 | 6W | 6 | 1.6 | 1500 | roller | 26 |

**Reciprocating compressor designation structure:**

□ G □ - □/□ - □ S □

- Climatic version type
  without lubrication of cylinders and rod seals (upon customer requirement)
- Discharge pressure, abs., kgf/cm$^2$
- Suction pressure, abs., kgf/cm$^2$
- Volumetric capacity reduced to suction conditions, m$^3$/min
- Reciprocating force per one raw, t
- Compressed medium – gas
- Number of compressor rows

Compressor designation example:

**4GM10-48/2-57S UHL4**

| | | |
|---|---|---|
| 4 | - | number of rows; |
| G | - | gas (compressed medium); |
| M10 | - | opposite with reciprocating force for one row - 10 t; |
| 48 | - | volumetric capacity reduced to suction conditions, m$^3$/min; |
| 2 | - | absolute suction pressure, kgf/cm$^2$; |
| 57 | - | absolute discharge pressure, kgf/cm$^2$; |
| S | - | version without lubrication of cylinders and rods seals; |
| UHL4 | - | climatic version as per GOST 15150 |

# 5 Basic Design Solutions

| Design solutions | Compressor base: | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | M 2,5 | M 4 | M 10 | M 10A | M 16 | M 25 | M 25A | M 40 |
| Number of rows | 2, 4 | 2 | 2, 4 | 2 | 2, 4, 6 | 4, 6 | 6 | 4, 6 |
| Number of main bearings | 2, 3, 4 | 2 | 3, 5 | 2 | 3, 5, 7 | 5,7 | 7 | 5, 7 |
| Moving mechanism lubrication | Sprinkling | | | Circulation under pressure | | | | |
| Lube oil pump drive | - | Crank shaft | | Auxiliary electric motor | | | | |
| Barring gear | no | no | yes | no | yes | yes | no | yes |
| End of crankshaft | keyed/ flange | | | | | | | |
| Lubrication of cylinders and rod seals | with lubrication | with lubrication/ w/o lubrication | with lubrication/ w/o lubrication | with lubrication | with lubrication/ w/o lubrication | with lubrication/ w/o lubrication | with lubrication | with lubrication/ w/o lubrication |
| Intermediate insert | Type A, B, C, D (as per API 618) | | | | | | | |
| **Main parts manufacturing method:** | | | | | | | | |
| Crankcase | Casting | | | | | | | |
| Crankshaft | Stamping | Forging | | | | | | |
| Connecting rod | Stamping | Forging | | | Forging/ Stamping | Forging | | |
| Connecting-rod bolt | Forging or machining of bar stock | | | | | | | |
| Connecting-rod nut | Forging or machining of bar stock | | | | | | | |
| Crosshead | Casting | Forging | | | | Casting | | |
| Crosshead pin | Forging or machining of bar stock | | | | | | | |
| Crosshead nut | Forging or machining of bar stock | | | | | | | |
| Intermediate insert | Casting | | | | | | | |
| Cylinder | Casting/Forging/Forging+welding | | | | | | | |
| Cylinder sleeve | Casting | | | | | | | |
| Cylinder cover | Casting/Forging | | | | | | | |
| Piston | Casting/Forging/Welding | | | | | | | |
| Rod | Forging or machining of bar stock | | | | | | | |
| Rod nut | Forging or machining of bar stock | | | | | | | |
| Valve cover | Forging | | | | | | | |
| Rod seal casing and flange | Forging | | | | | | | |
| Valve body | Forging | | | | | | | |
| Valve plate | Sheet machining | | | | | | | |
| Valve spring | Broaching | | | | | | | |

# 6 Design Features of Reciprocating Compressors and Parts thereof

**Compressor**

1. Forged steel crankshaft for heavy duties.
2. Horizontally balanced opposite rows.
3. Crossheads made of casted steel with iron shoes (babbit filled) or aluminum shoes. Forced lube oil supply under pressure to upper and lower sliding surfaces for minimum wear.
4. Forged steel connecting rods.
5. Barring gear.

**Cylinders and piston groups**

1. Cylinders with bottom part and rod seals mounted therein (fig. 1) and without bottom part with rod seals mounted into intermediate insert (fig. 2).
2. Guide (journal) rings of pistons for lubricated and non-lubricated operation.
3. Indication of cylinder cavities.
4. Rod seals purging.
5. Rod seals cooling with cooling fluid (water, anti-freezing agent) or oil.
6. Cylinders structure without cooling or with cooling with cooling fluid.
7. Piston rods made of alloyed or corrosion resistant steel.

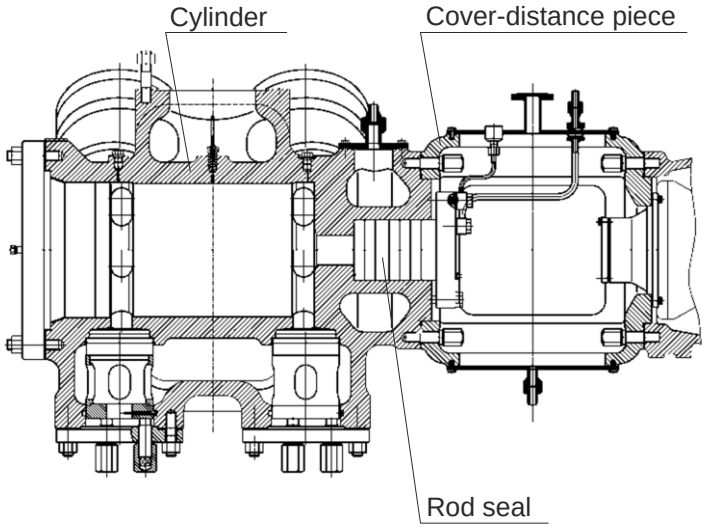



Figure 1

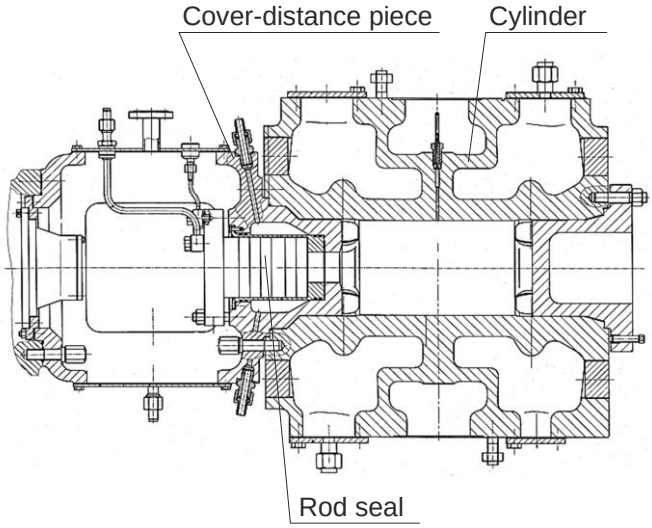



Figure 2

**Valves**

Disc, ring or band automatic valves depending on compressed gas and average speed of piston.

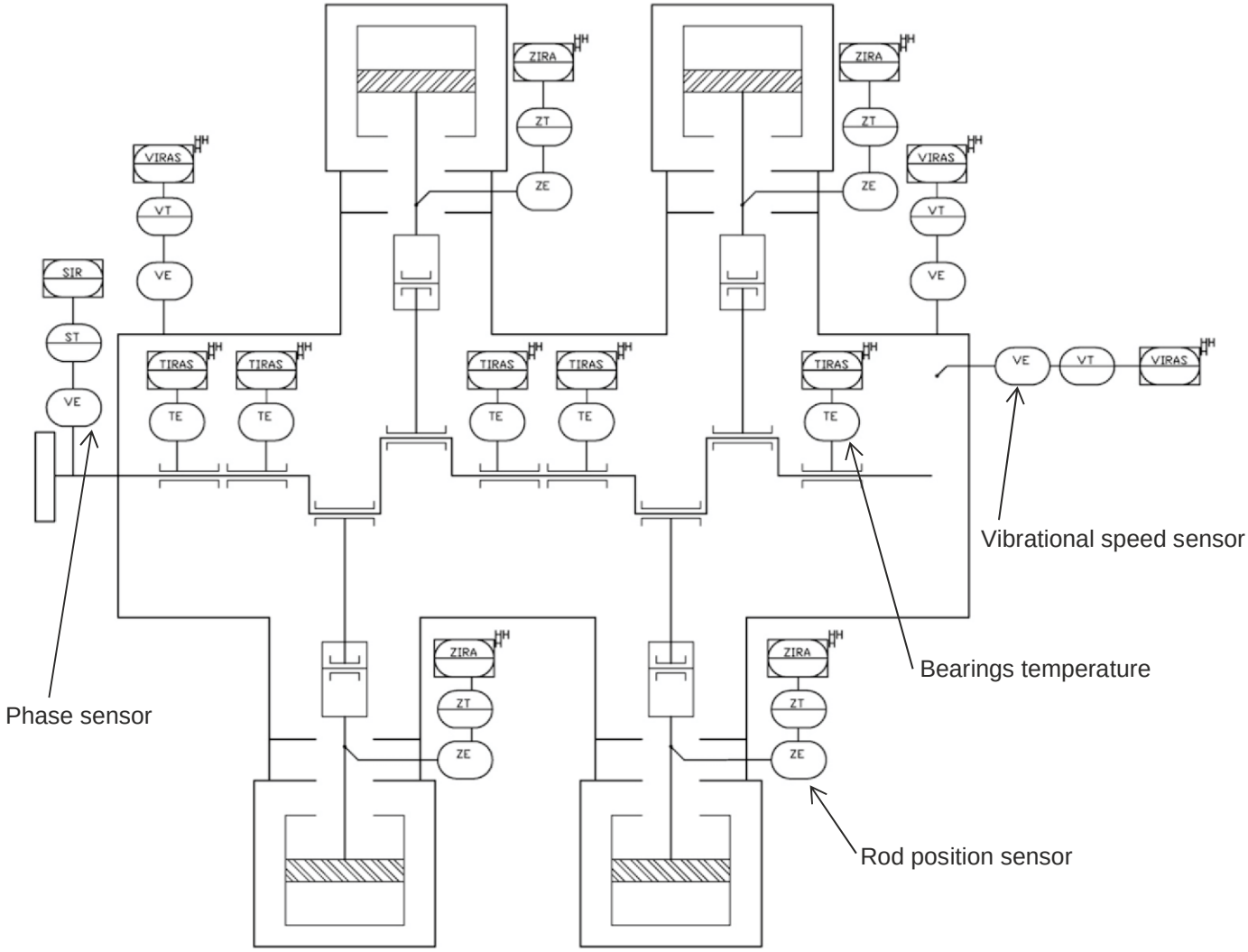
**Capacity regulating devices (unloaders)**

1. Additional dead space.
2. Pressing of plates of suction valves (Hoerbiger, CPI).

**Pulsation suppression device**

Buffer suction and discharge vessels for each compressor stage.

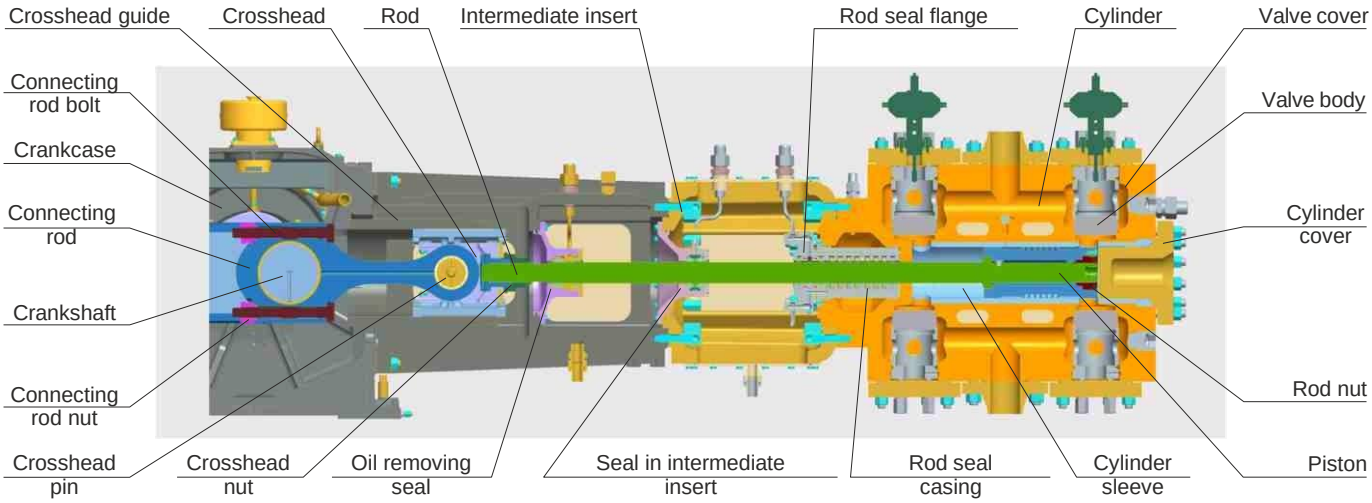
**Vibration monitoring typical diagram**




Vibration monitoring system provides continuous monitoring of temperature of connection rod bearings and control of wear of piston guide rings per rod vertical displacement (installation of additional sensors for rod horizontal displacement is possible) depending on the turn angle of compressor crankshaft as well as compressor crankcase vibrational speed control including archivation, processing and visualization of information, possessing warnings and alarms.

# 8 Marking of Reciprocating Compressors Parts and Components

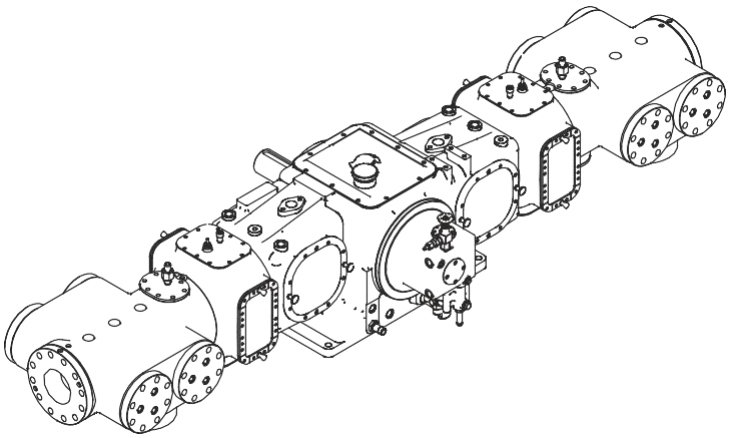
| Part/component | Marking method | Marking data |
|---|---|---|
| Compressor | on nameplate | According to API 618 |
| Crankcase | impact | Designation as per drawing, material grade, product No. |
| Main bearings covers | impact | Designation as per drawing, material grade, bearing consecutive number |
| Main and connecting-rod bearings bushings | impact | Thickness, distance of joints undercut, melting No. of babbit filling |
| Crankshaft | impact | Designation as per drawing, material grade, melting No., product No. |
| Connecting rod | impact | Designation as per drawing, compressor row No., material grade, sample No. |
| Connecting rod bolt | impact | Designation as per drawing, material grade, sample No. |
| Connecting rod nut | impact | Designation as per drawing, material grade |
| Crosshead | impact | Designation as per drawing, material grade, melting No., product No., row No. |
| Crosshead pin | impact | Designation as per drawing, material grade, melting No. |
| Crosshead nut | impact | Designation as per drawing, material grade |
| Cylinder group | on nameplate | According to API 618 |
| Guide | impact | Designation as per drawing, material grade |
| Intermediate insert (distance piece) | impact | Designation as per drawing, material grade |
| Cylinders | impact | Designation as per drawing, material grade, product No., melting No. |
| Rod | impact | Designation as per drawing, material grade, product No. |
| Piston | impact | Designation as per drawing, material grade, product No. |
| Piston nut | impact | Designation as per drawing, material grade, product No. |

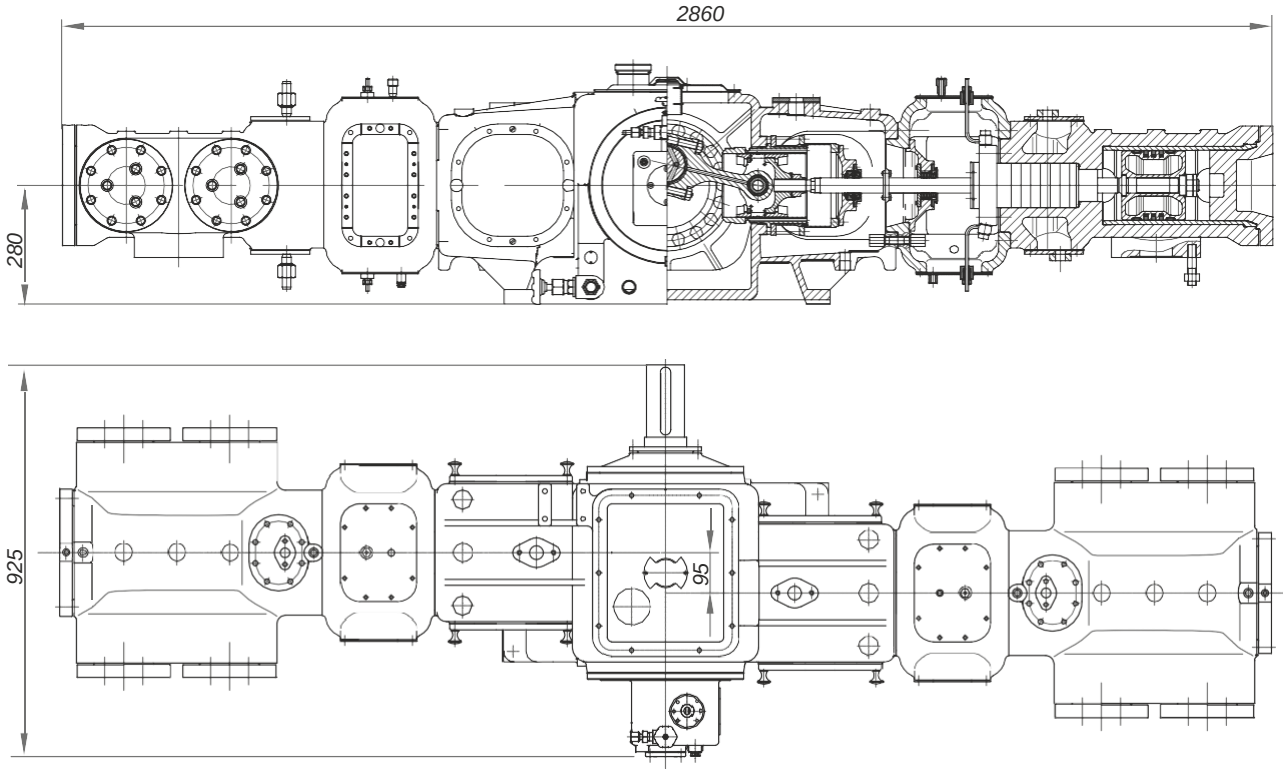


# 9 Materials Used for Manufacturing of Compressor Parts

| Part | Material as per GOST | Material analogue as per ASME/AISI |
|---|---|---|
| Crankcase | СЧ20 | A48-No.30B |
| Crankshaft | 40, 40ХН, 45, 38Х2МЮА | A105, 3140, A107, J24056 (K24065) |
| Connecting rod | 40, 45, 40ХН, 30ХМА-Ш | A105, A107, 3140, 4130 |
| Connecting rod bolt | 40ХН2МА-Ш | 4340 (9840) |
| Connecting rod nut | 40Х, 40ХН, 38ХА | 5140, 3140, 5140H |
| Crosshead | 20ГЛ, 38Х2МЮА | A352GrLCC, J24056 |
| Crosshead pin | 20, 20Х | A105, 5120 |
| Crosshead nut | 40, 40Х | 1040, 5140 |
| Intermediate insert | СЧ20, СЧ25, СЧ30, 12Х18Н9ТЛ | A48-No.30B, No.35B, No.45B |
| Cylinder | СЧ20, СЧ25, СЧ30, СЧ35, 20, 35, 40, 20ГЛ, 20ГМЛ, 20ЮЧ, 40Х, 12Х18Н9ТЛ, 08Х18Н10Т, 03Х17Н14М3 | A48-No.30B, No.35B, No.45B, No.50B; A105, 1035, 1040, A352GrLCC, 5140, J92630, 321, 316L |
| Cylinder sleeve | СЧ25, СЧ30, СЧ35, 20Х13, 30Х13, 40Х13, 38Х2МЮА-Ш | A48-No.35B, No.45B, No.50B; A420, J24056 (K24065) |
| Cylinder cover | СЧ20, СЧ25, СЧ30, СЧ35, 20, 35, 40, 40Х, 20ГЛ, 20ГМЛ, 20ЮЧ, 12Х18Н9ТЛ, 08Х18Н10Т, 03Х17Н14М3 | A48-No.30B, No.35B, No.45B, No.50B; A105, 1035, 1040, 5140 A352GrLCC, J92630, 321H, 321, 316L |
| Piston | СЧ20, СЧ25, СЧ30, 20, 35, 40, 45, 38ХА, 38Х2МЮА, 38ХН3МФА-Ш, 20Х13, 12Х18Н10Т, 08Х17Н15М3Т | A48-No.30B, No.35B, No.45B; A105, 1035, 1040, A107, 5140H, J24056 (K24065), 4330, A420, 321H, 316Ti |
| Rod | 38Х2МЮА-Ш, 40ХН2МА-Ш, 20Х13-Ш, 30Х13, 40Х13 | J24056 (K24065), 4340, A420 |
| Rod nut | 35, 40, 40Х, 38ХА, 12Х13, 20Х13, 30Х13 | 1035, 1040, 5140, 5140H, A403, A420 |
| Valve cover | 35, 40, 40Х, 38ХА, 20ЮЧ, 30Х13, 10Х17Н13М3Т | 1035, 1040, 5140, 5140H, SA-333 Gr3, A420, 316Ti |
| Rod seal casing and flange | 35, 40, 45, 40Х, 40ХН, 20Х13, 08Х17Н15М3Т | 1035, 1040, 5140, 3140H, A420, 316Ti |
| Valve body | 20Х13 | A420 |
| Valve plate | 30Х13, purchased Lange Consulting | A420 |
| Valve spring | 12Х18Н10Т | 321H |

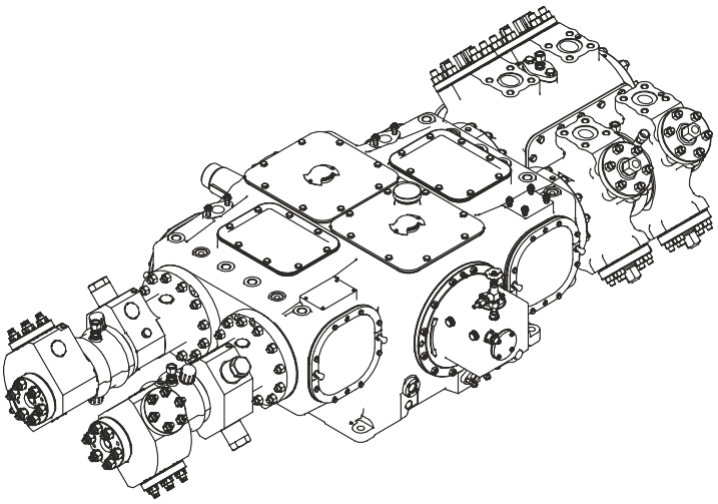
# 10 Compressor on 2GM2.5 base

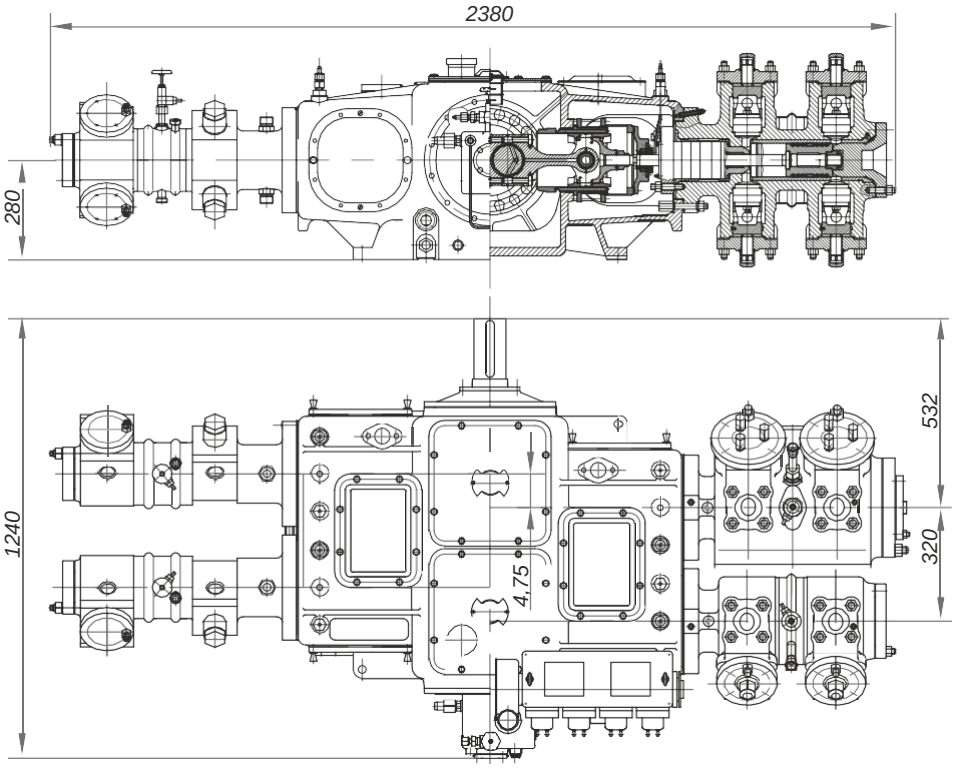





| Specifications | | |
|---|---|---|
| Type of compressor | | reciprocating, double row on opposite base 2GM2.5 |
| Reciprocating force | t | 2.5 |
| Number of rows | | 2 |
| Piston stroke | mm | 100 |
| Maximum rotational speed of crankshaft | rpm | 1000 |
| Maximum capacity at compressor shaft | kW | 130 |
| Type of bearings | | roller bearings |

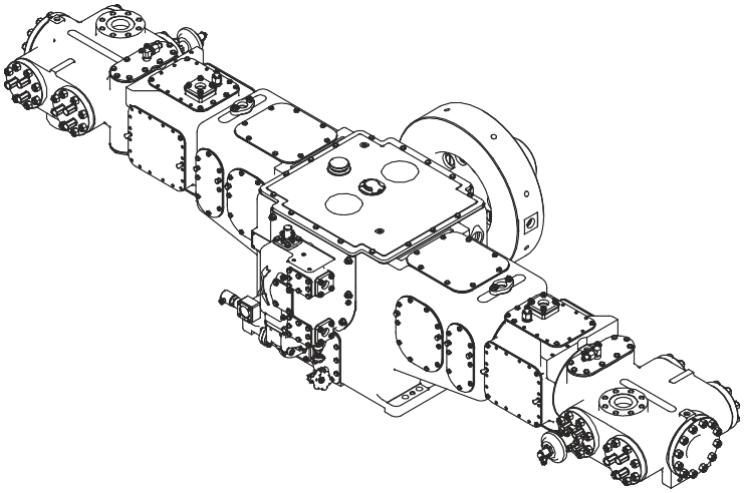
# 11 Compressor on 4GM2.5 base

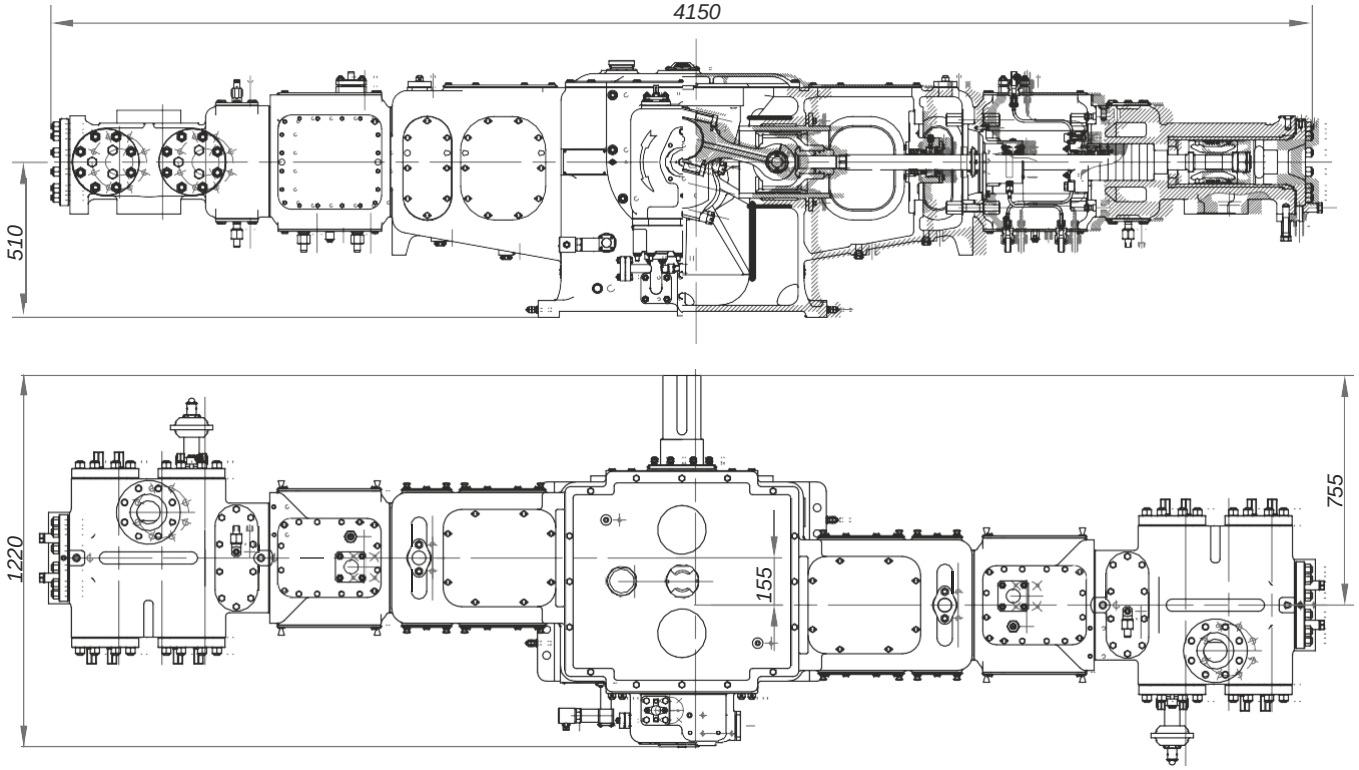





| Specifications | | |
|---|---|---|
| Type of compressor | | reciprocating, four row on opposite base 4GM2.5 |
| Reciprocating force | t | 2,5 |
| Number of rows | | 4 |
| Piston stroke | mm | 100 |
| Maximum rotational speed of crankshaft | rpm | 1000 |
| Maximum capacity at compressor shaft | kW | 260 |
| Type of bearings | | roller bearings |

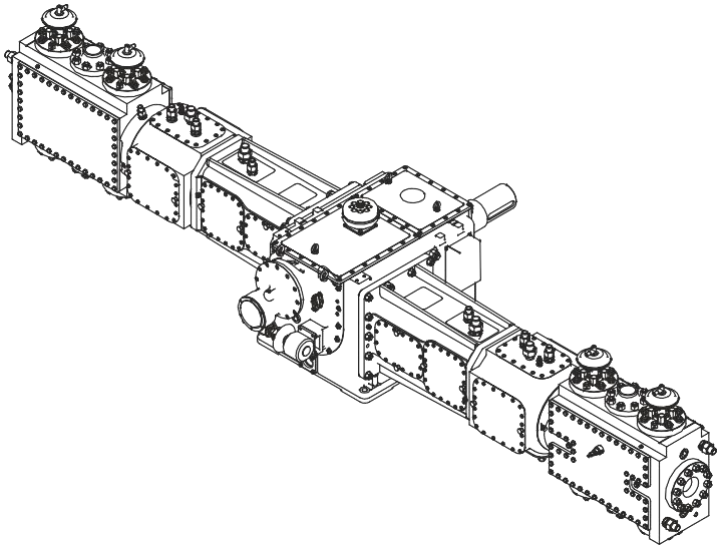
# Compressor on 2GM4 base

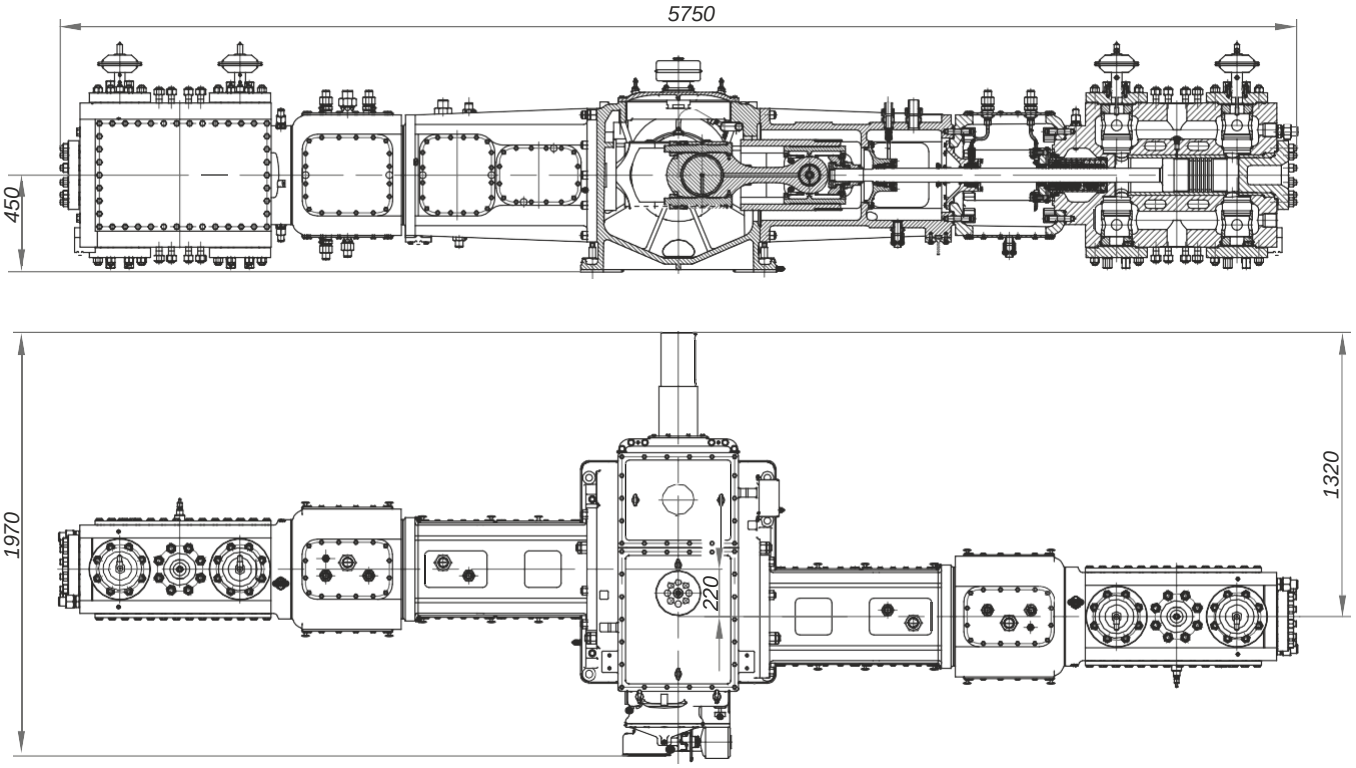





| Specifications | | |
|---|---|---|
| Type of compressor | | reciprocating, four row on opposite base 2GM4 |
| Reciprocating force | t | 4 |
| Number of rows | | 2 |
| Piston stroke | mm | 150 |
| Maximum rotational speed of crankshaft | rpm | 750 |
| Maximum capacity at compressor shaft | kW | 200 |
| Type of bearings | | sliding bearings |

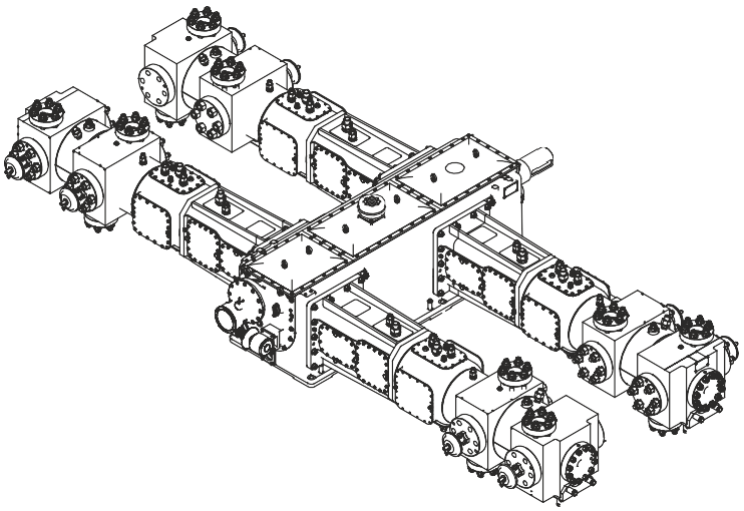
# Compressor on 2GM10 base

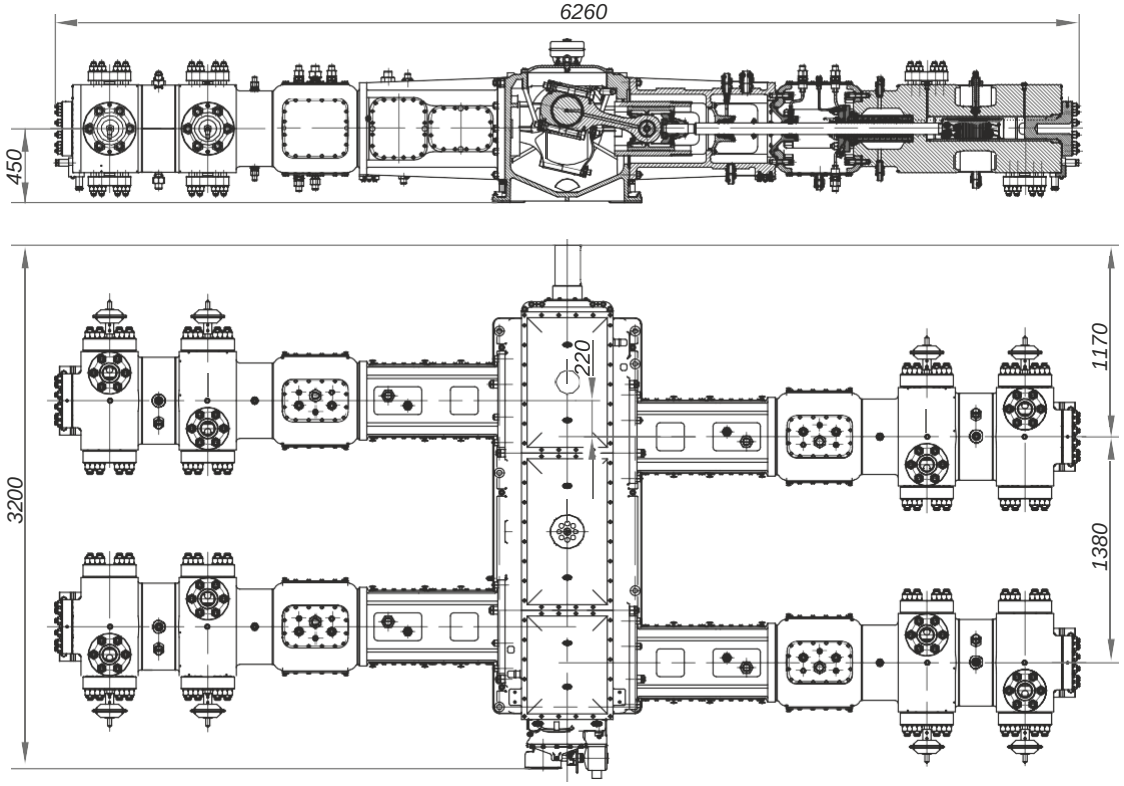





| Specifications | | |
|---|---|---|
| Type of compressor | | reciprocating, double row on opposite base 2GM10 |
| Reciprocating force | t | 10 |
| Number of rows | | 2 |
| Piston stroke | mm | 220 |
| Maximum rotational speed of crankshaft | rpm | 600 |
| Maximum capacity at compressor shaft | kW | 580 |
| Type of bearings | | sliding bearings |

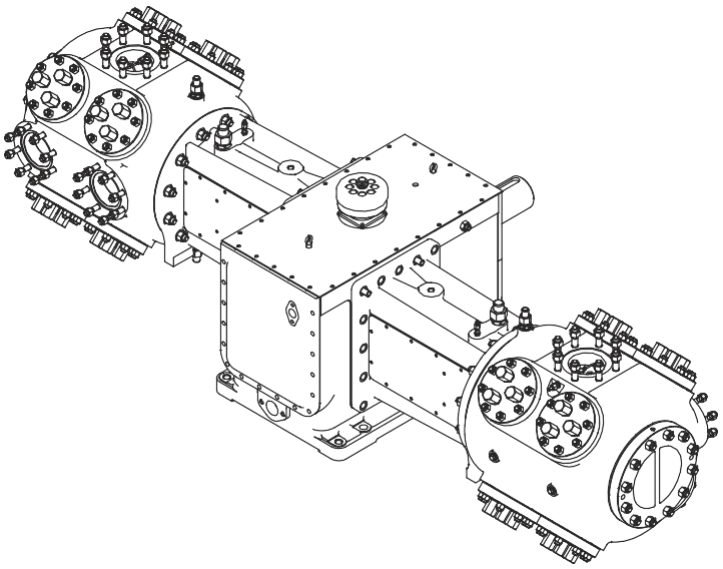
# Compressor on 4GM10 base

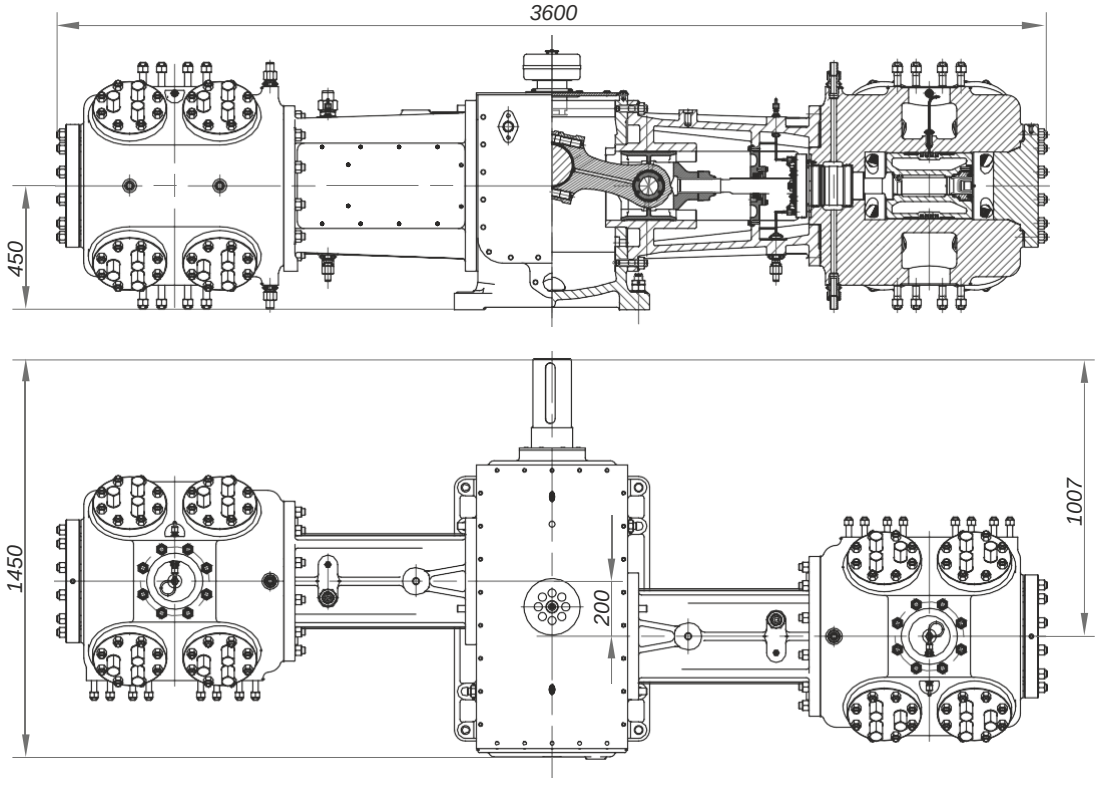





| Specifications | | |
|---|---|---|
| Type of compressor | | reciprocating, four row on opposite base 4GM10 |
| Reciprocating force | t | 10 |
| Number of rows | | 4 |
| Piston stroke | mm | 220 |
| Maximum rotational speed of crankshaft | rpm | 600 |
| Maximum capacity at compressor shaft | kW | 1000 |
| Type of bearings | | sliding bearings |

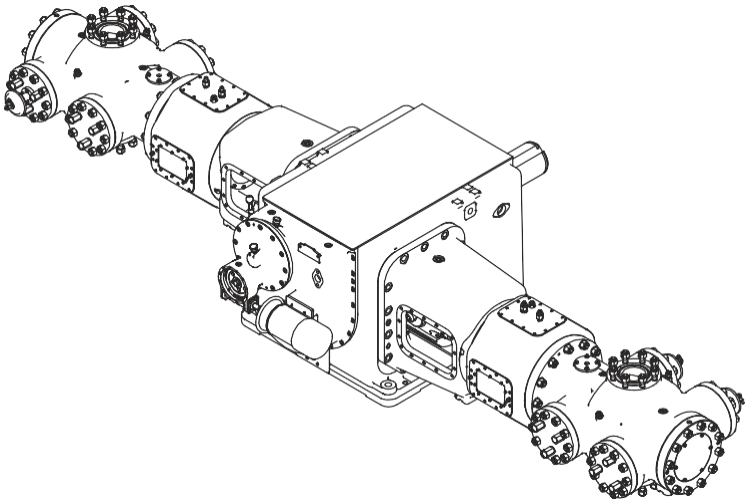
# Compressor on 2GM10A base

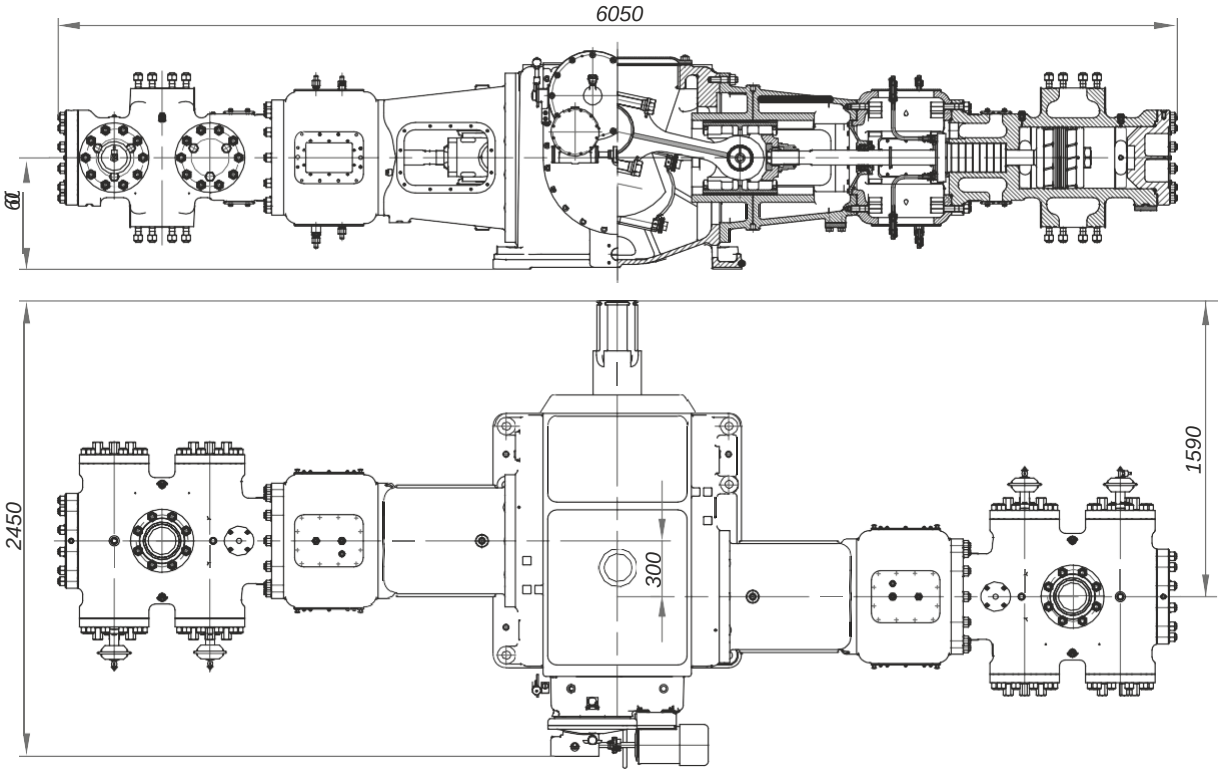





| Specifications | | |
|---|---|---|
| Type of compressor | | reciprocating, double row on opposite base 2GM10A |
| Reciprocating force | t | 10 |
| Number of rows | | 2 |
| Piston stroke | mm | 150 |
| Maximum rotational speed of crankshaft | rpm | 1000 |
| Maximum capacity at compressor shaft | kW | 580 |
| Type of bearings | | sliding bearings |

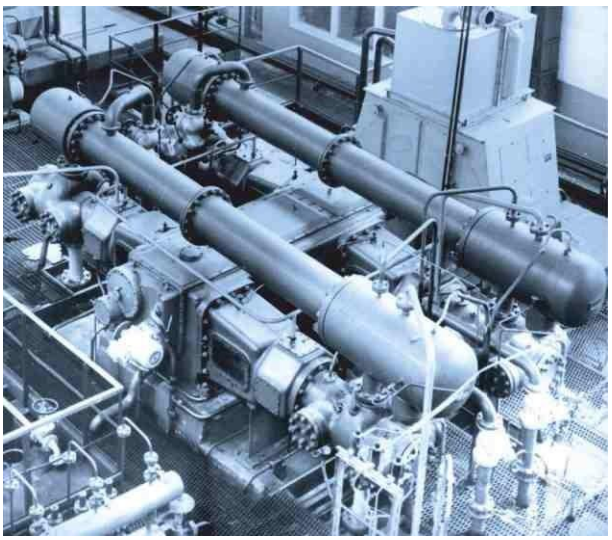
# Compressor on 6GM16 base

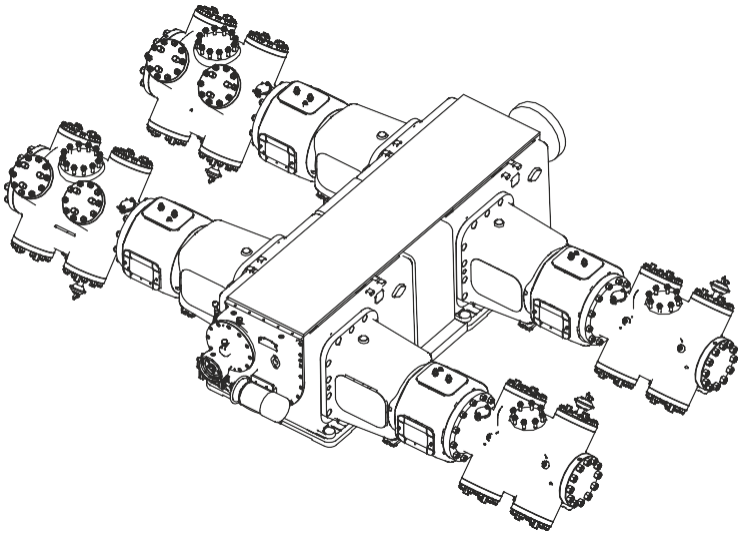


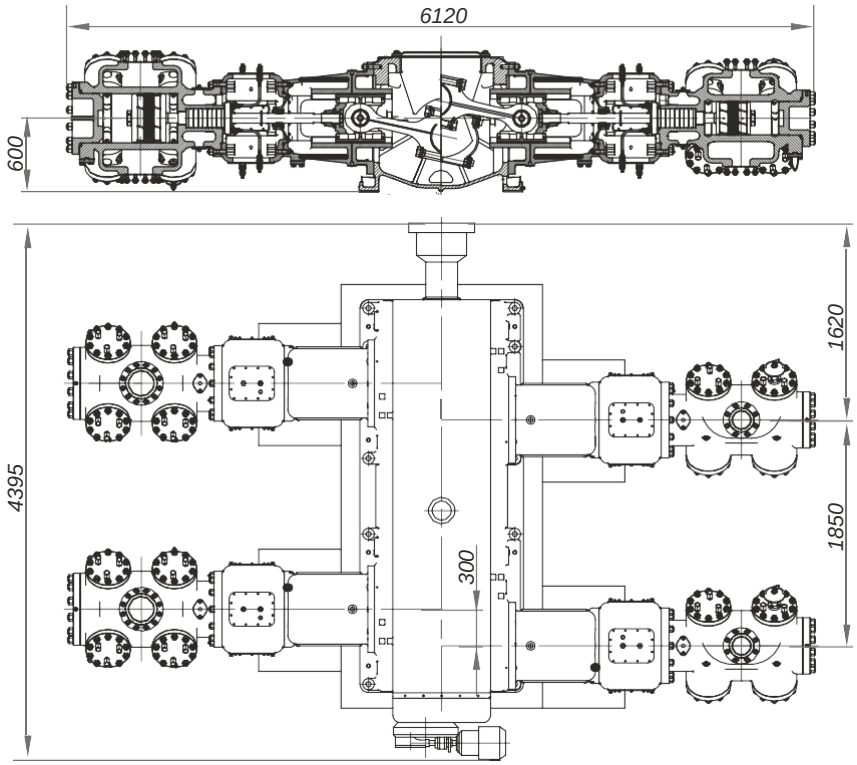



| Specifications | | |
|---|---|---|
| Type of compressor | | 1.reciprocating, double row on opposite base 2GM16 |
| Reciprocating force | t | 16 |
| Number of rows | | 2 |
| Piston stroke | mm | 320 |
| Maximum rotational speed of crankshaft | rpm | 375 |
| Maximum capacity at compressor shaft | kW | 1110 |
| Type of bearings | | sliding bearings |

# Compressor on 4GM25 base

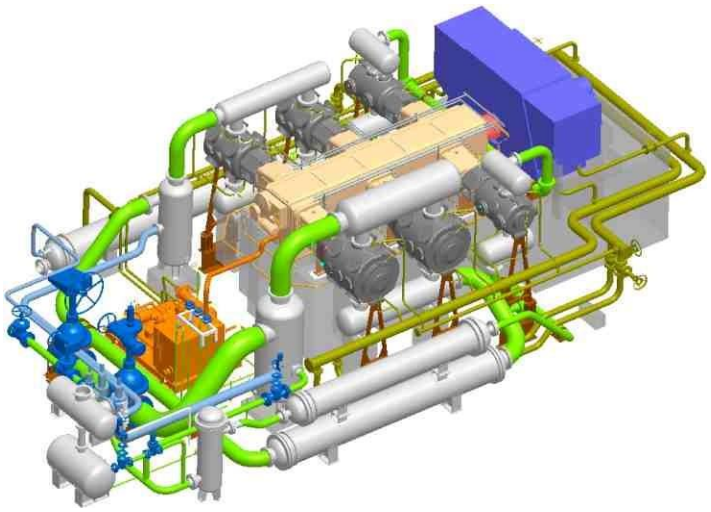


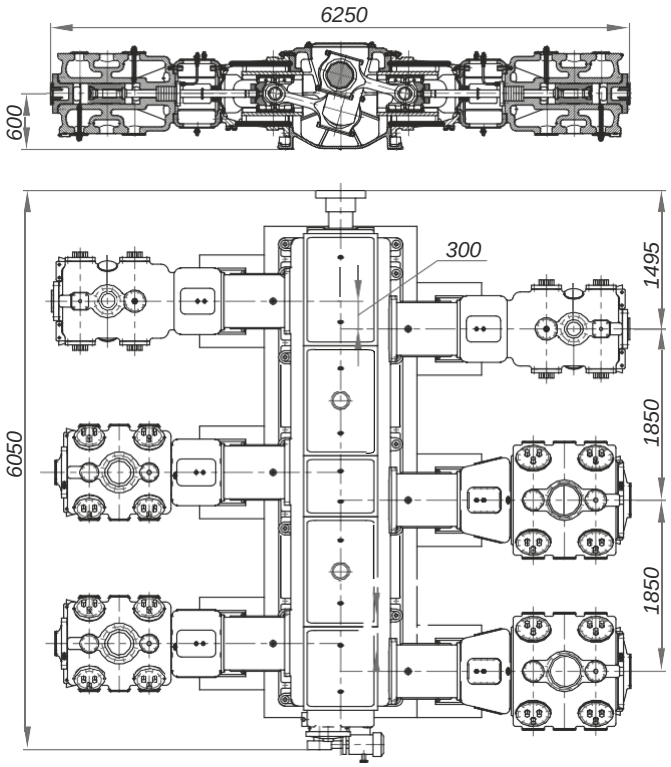





| Specifications | | |
|---|---|---|
| Type of compressor | | reciprocating, four row on opposite base 4GM16 |
| Reciprocating force | t | 16 |
| Number of rows | | 4 |
| Piston stroke | mm | 320 |
| Maximum rotational speed of crankshaft | rpm | 375 |
| Maximum capacity at compressor shaft | kW | 2200 |
| Type of bearings | | sliding bearings |

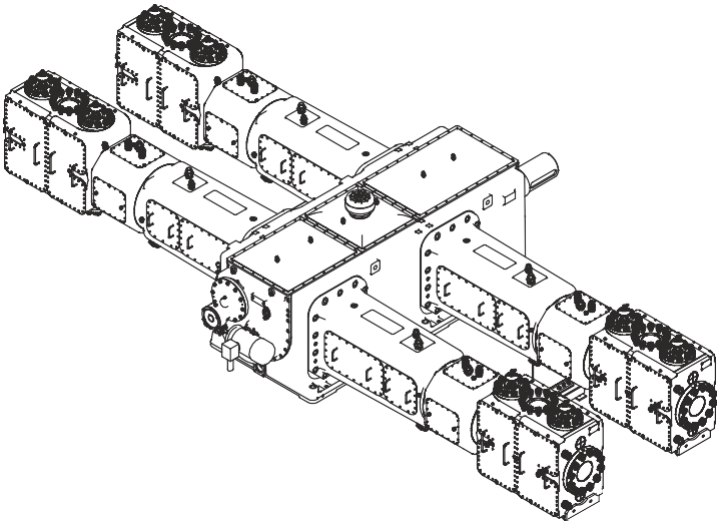
# Compressor on 6GM16 base

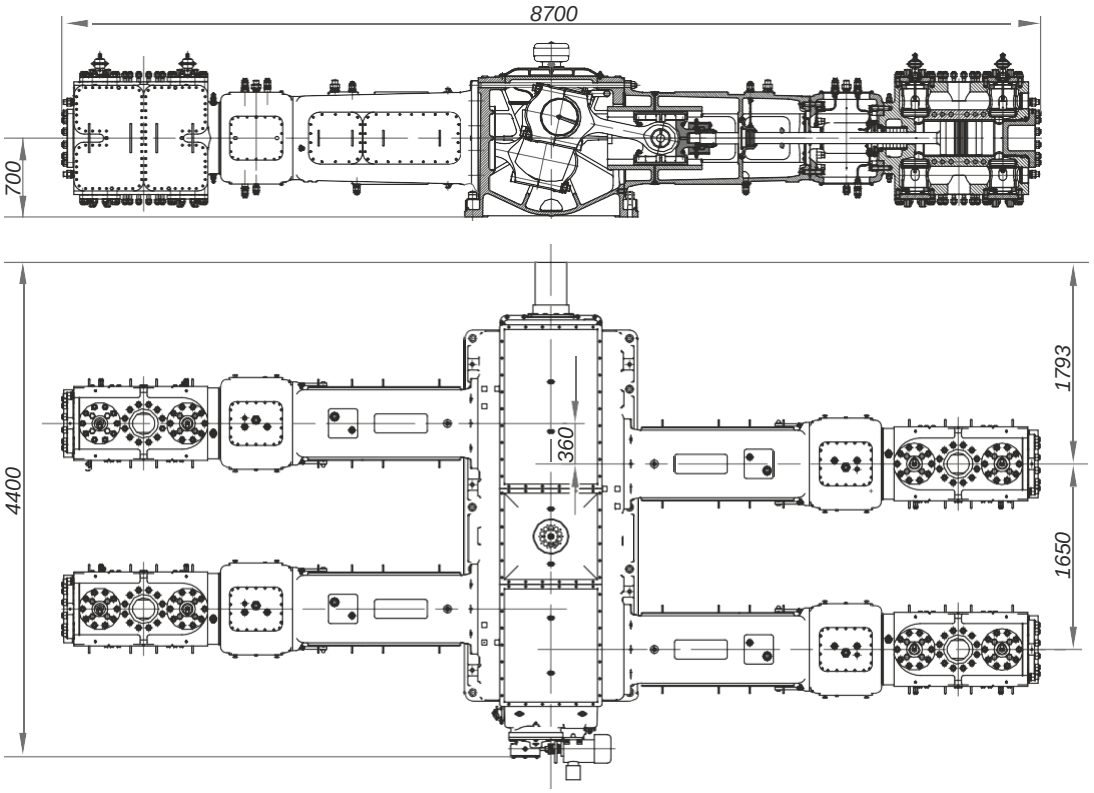





| Specifications | | |
|---|---|---|
| Type of compressor | | reciprocating, six row on opposite base 6GM16 |
| Reciprocating force | t | 16 |
| Number of rows | | 6 |
| Piston stroke | mm | 320 |
| Maximum rotational speed of crankshaft | rpm | 375 |
| Maximum capacity at compressor shaft | kW | 2475 |
| Type of bearings | | sliding bearings |

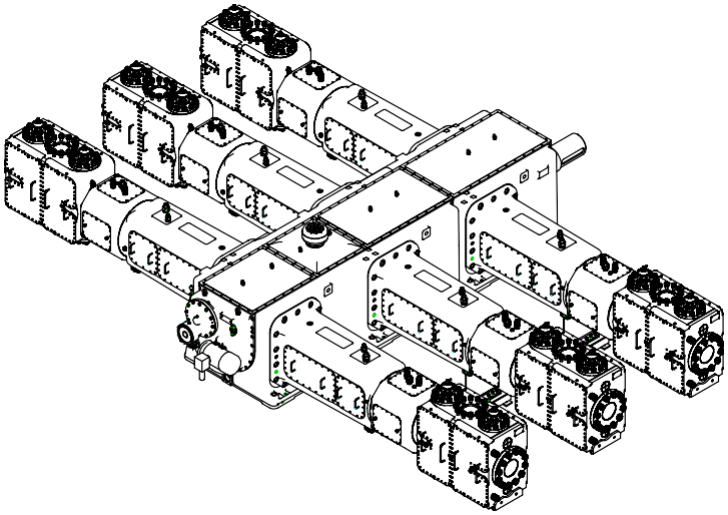
# Compressor on 4GM25 base

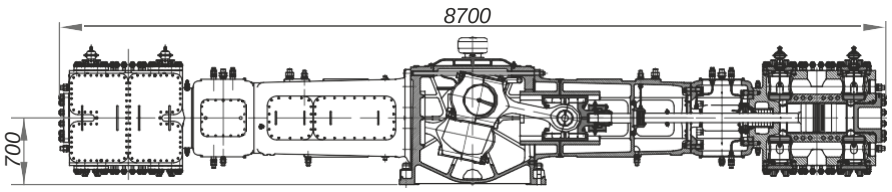


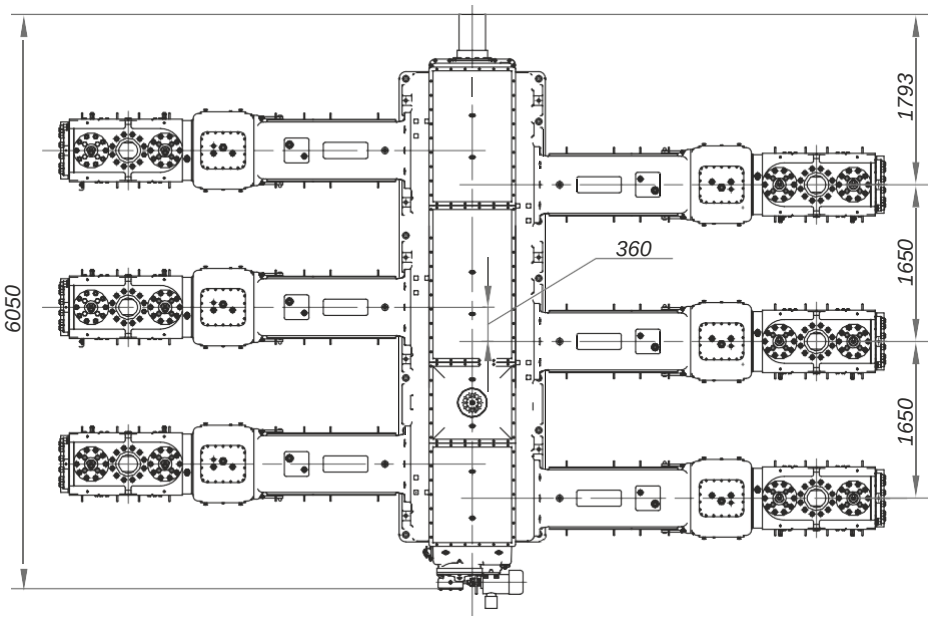



| Specifications | | |
|---|---|---|
| Type of compressor | | reciprocating, four row on opposite base 4GM25 |
| Reciprocating force | t | 25 |
| Number of rows | | 4 |
| Piston stroke | mm | 400 |
| Maximum rotational speed of crankshaft | rpm | 325 |
| Maximum capacity at compressor shaft | kW | 3100 |
| Type of bearings | | sliding bearings |

# Compressor on 6GM25 base

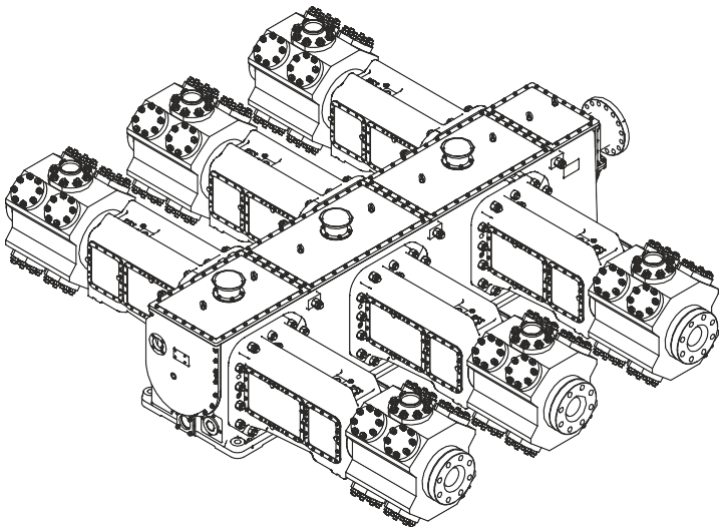


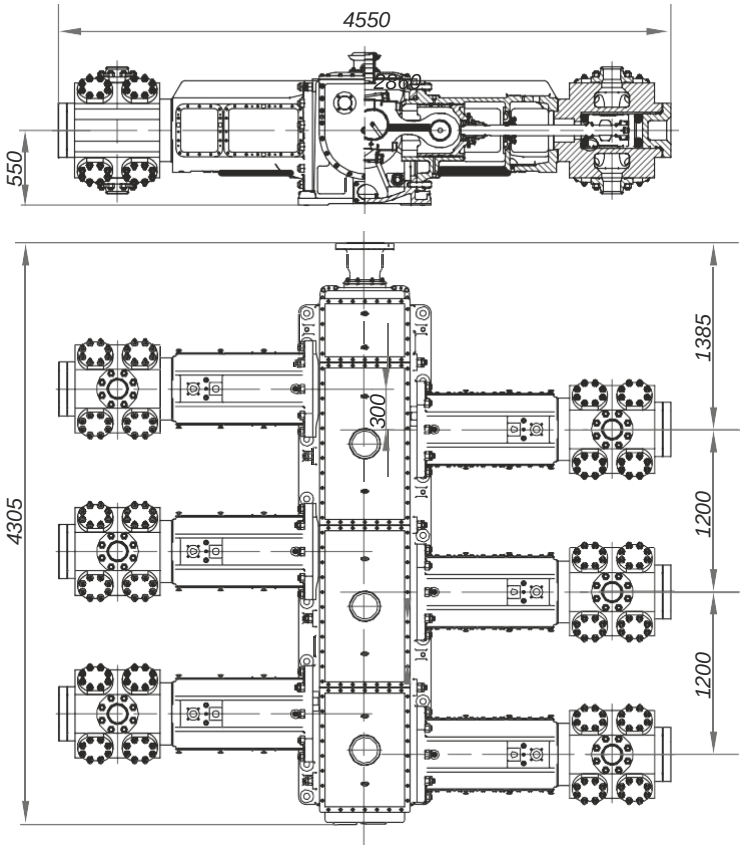



| Specifications | | |
|---|---|---|
| Type of compressor | | reciprocating, six row on opposite base 6GM25 |
| Reciprocating force | t | 25 |
| Number of rows | | 6 |
| Piston stroke | mm | 400 |
| Maximum rotational speed of crankshaft | rpm | 375 |
| Maximum capacity at compressor shaft | kW | 4710 |
| Type of bearings | | sliding bearings |

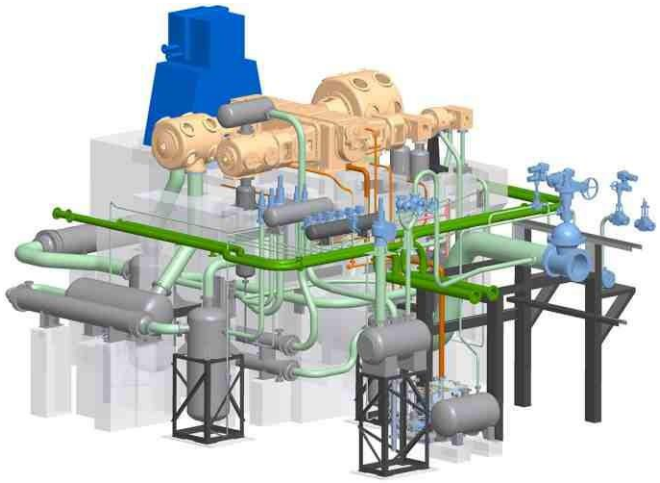
# Compressor on 6GM25A base

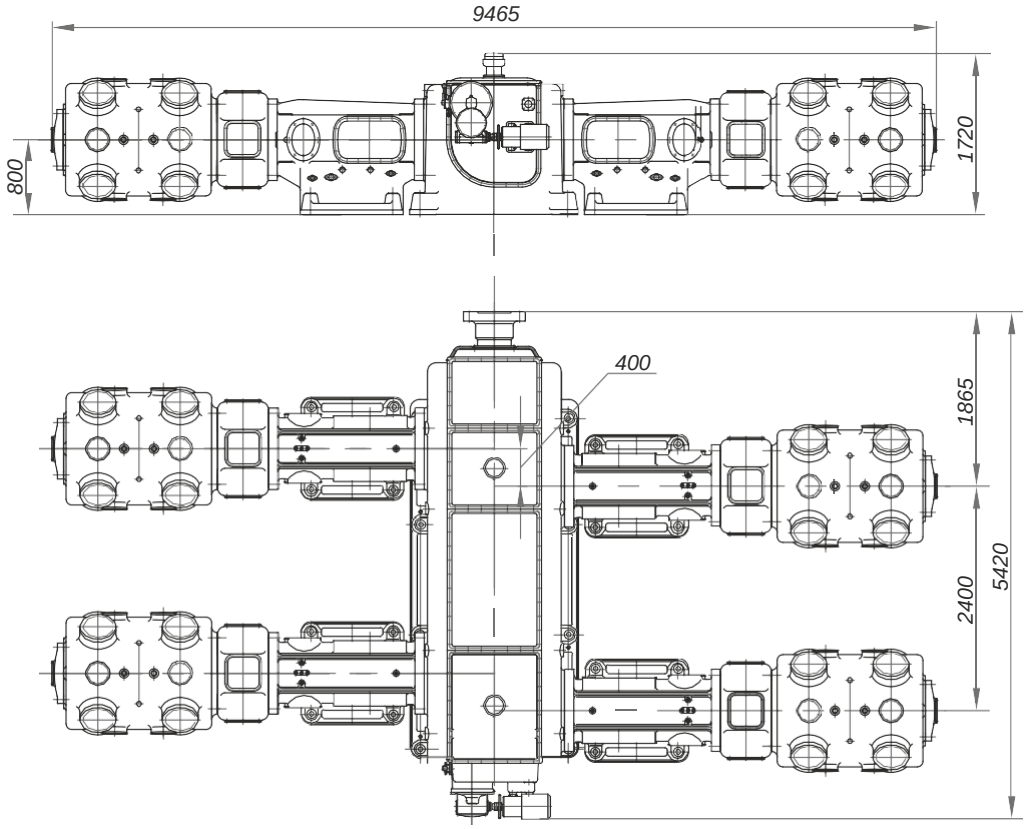





| Specifications | | |
|---|---|---|
| Type of compressor | | reciprocating, six row on opposite base 6GM25A |
| Reciprocating force | t | 25 |
| Number of rows | | 6 |
| Piston stroke | mm | 150 |
| Maximum rotational speed of crankshaft | rpm | 1000 |
| Maximum capacity at compressor shaft | kW | 4700 |
| Type of bearings | | sliding bearings |

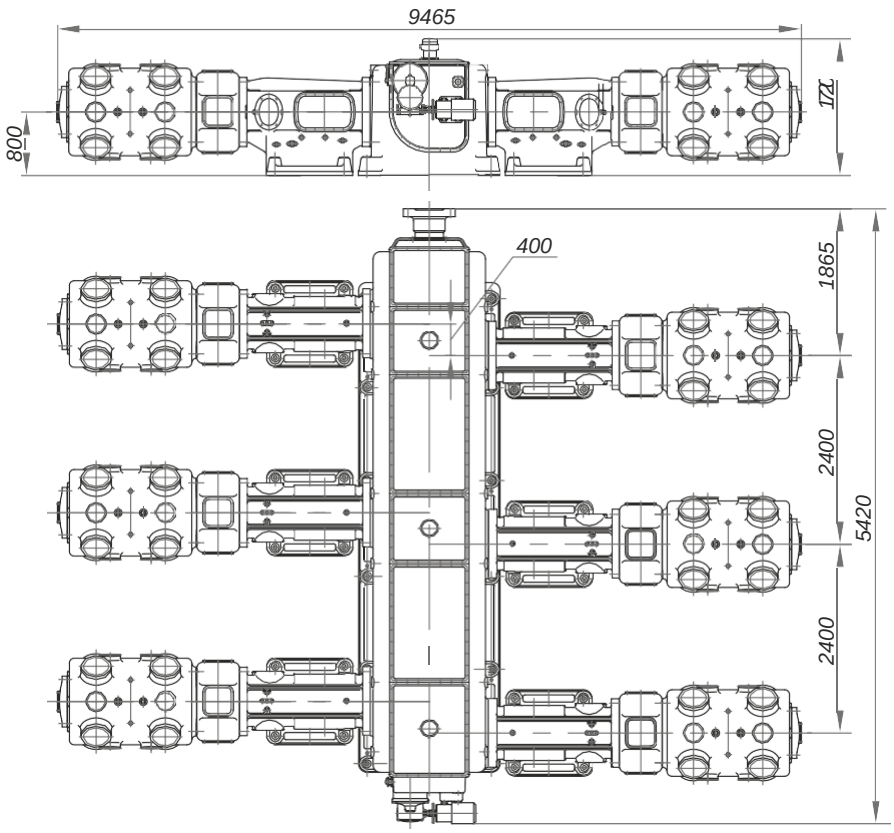
# Compressor on 6GM25 base





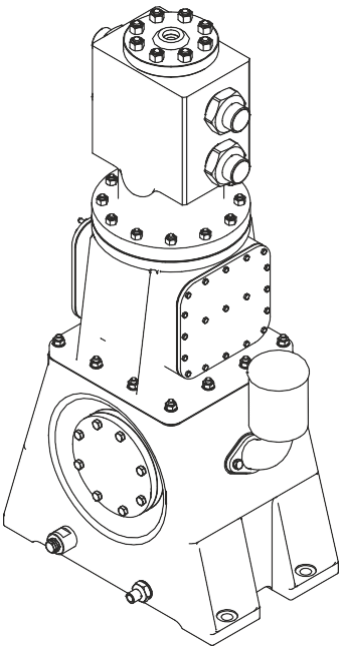

| Specifications | | |
|---|---|---|
| Type of compressor | | reciprocating, four row on opposite base 4GM40 |
| Reciprocating force | t | 40 |
| Number of rows | | 4 |
| Piston stroke | mm | 450 |
| Maximum rotational speed of crankshaft | rpm | 300 |
| Maximum capacity at compressor shaft | kW | 4500 |
| Type of bearings | | sliding bearings |

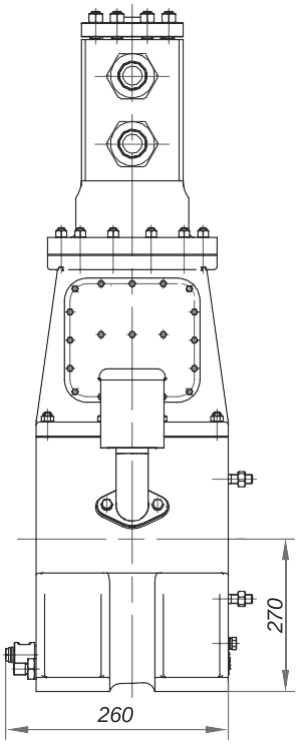
# Compressor on 6GM40 base

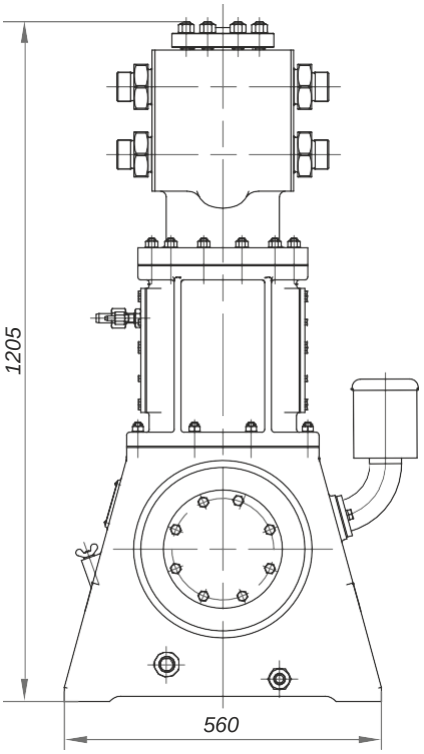



| Specifications | | |
|---|---|---|
| Type of compressor | | reciprocating, six row on opposite base 6GM40 |
| Reciprocating force | t | 40 |
| Number of rows | | 6 |
| Piston stroke | mm | 450 |
| Maximum rotational speed of crankshaft | rpm | 300 |
| Maximum capacity at compressor shaft | kW | 6750 |
| Type of bearings | | sliding bearings |

# Compressor on GT1 base

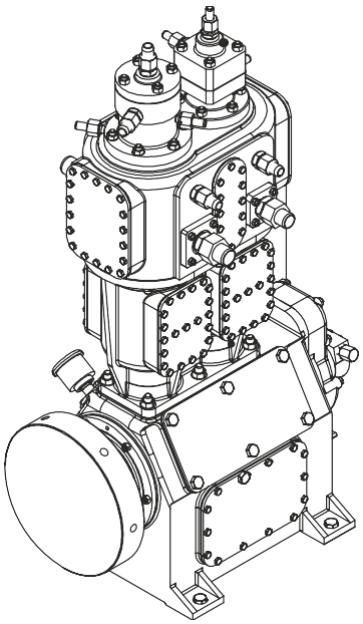


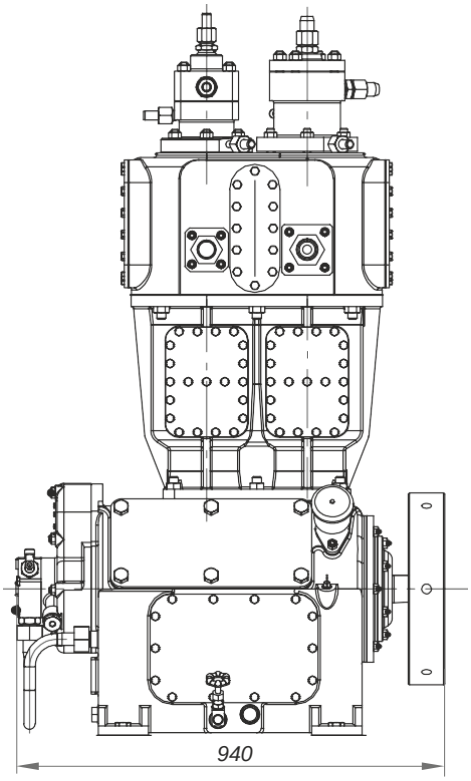


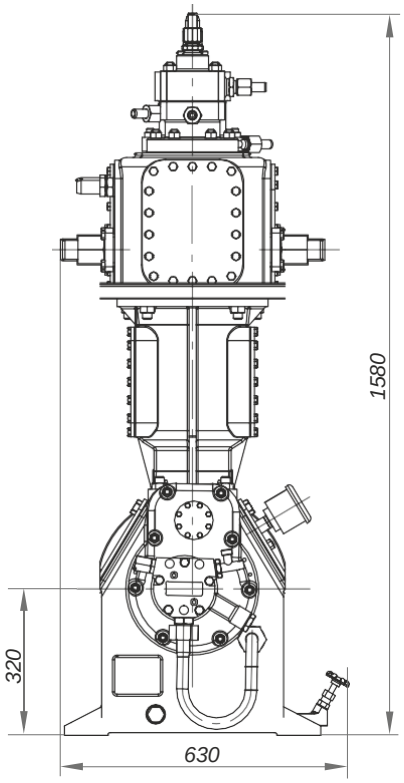




| Specifications | | |
|---|---|---|
| Type of compressor | | reciprocating, vertical, crosshead, based on GT1 |
| Reciprocating force | t | 1.0 |
| Number of rows | | 1 |
| Piston stroke | mm | 60 |
| Maximum rotational speed of crankshaft | rpm | 1000 |
| Maximum capacity at compressor shaft | kW | 20 |
| Type of bearings | | roller bearings |

# Compressor on 2GT1.6 base

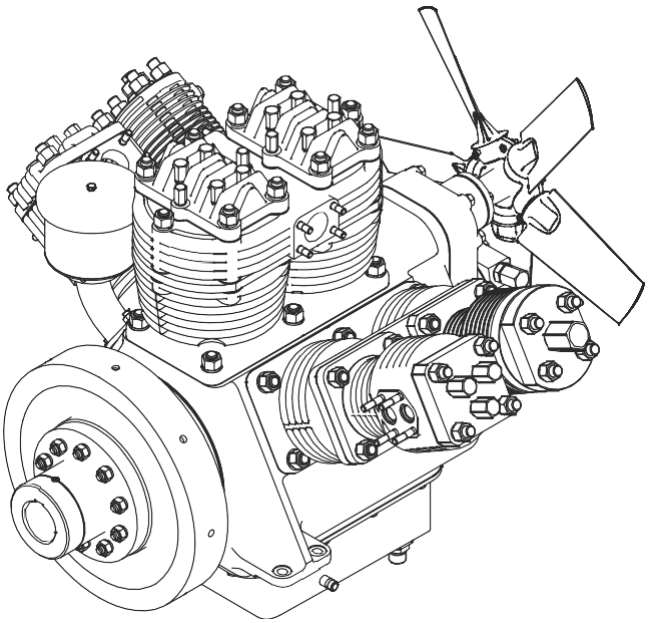


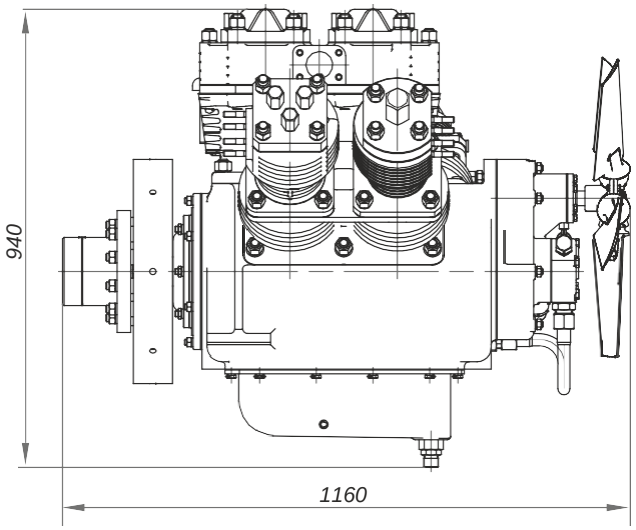


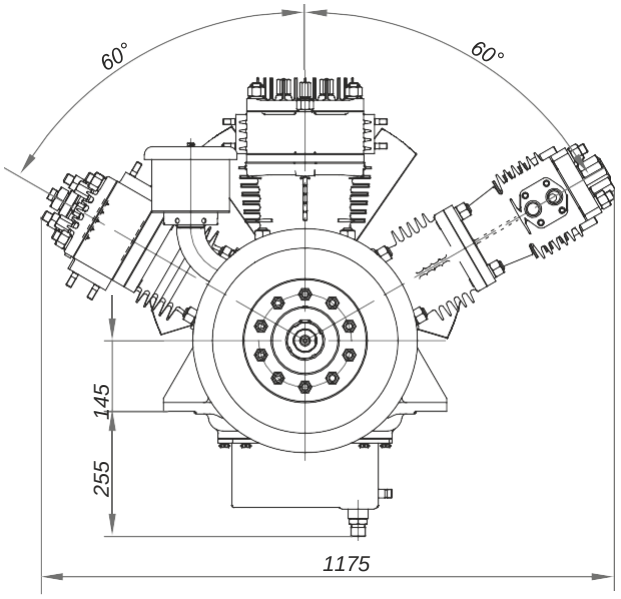




| Specifications | | |
|---|---|---|
| Type of compressor | | reciprocating, vertical, crosshead, based on 2GT 1.6 |
| Reciprocating force | t | 1.6 |
| Number of rows | | 2 |
| Piston stroke | mm | 60 |
| Maximum rotational speed of crankshaft | rpm | 1000 |
| Maximum capacity at compressor shaft | kW | 45 |
| Type of bearings | | roller bearings |

# Compressor on 6W base






| Specifications | | |
|---|---|---|
| Type of compressor | | reciprocating, crosshead, W-shaped, with cylinders' air cooling |
| Reciprocating force | t | 1.6 |
| Number of rows | | 6 |
| Piston stroke | mm | 60 |
| Maximum rotational speed of crankshaft | rpm | 1500 |
| Maximum capacity at compressor shaft | kW | 75 |
| Type of bearings | | roller bearings |

# 27 Certificates and Approvals

**Certificates of compliance:**

- Certificate of quality management system compliance with ISO 9001:2015 standard;
- Certificate of compliance of industrial health and safety management system with ISO 45001:2018 standard;
- Certificate of compliance of environmental protection management system with ISO 14001:2015 standard;
- Certificates of conformity with API 618 for reciprocating compressors on opposite base with piston load of 2.5, 4, 10, 16 and 25 tons per one row;
- ASME Manufacture Approval Certificate.