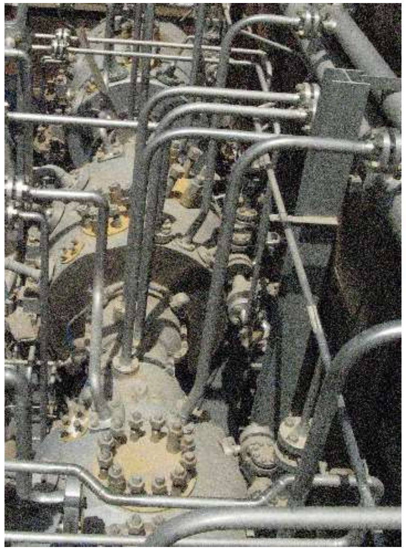
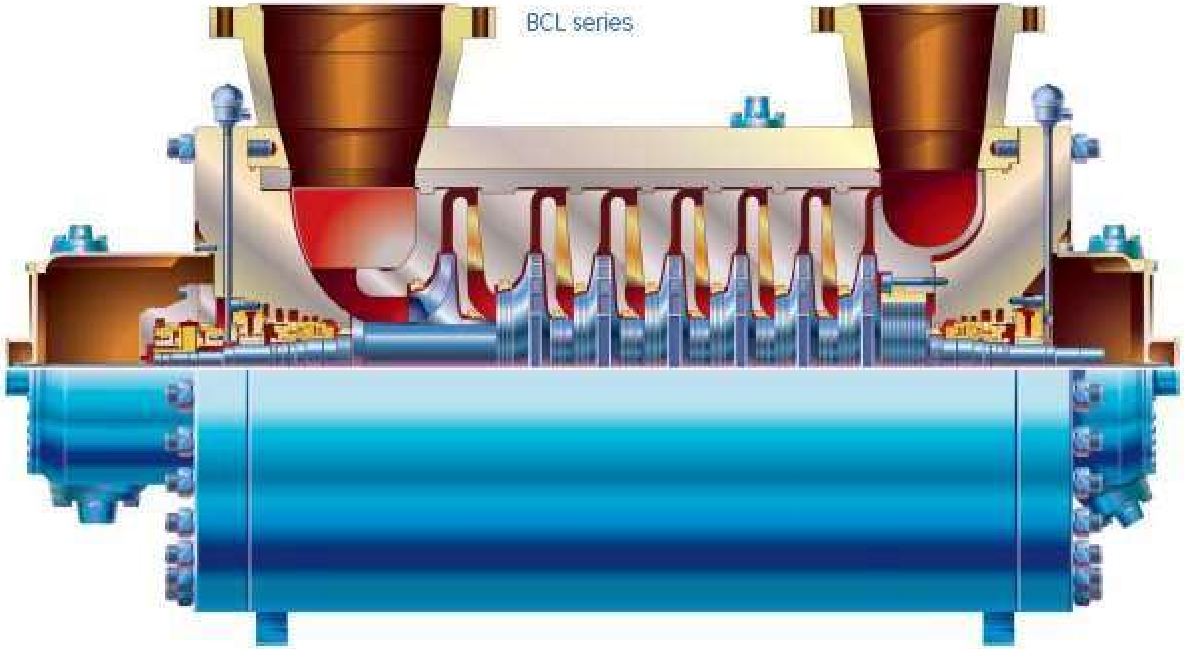
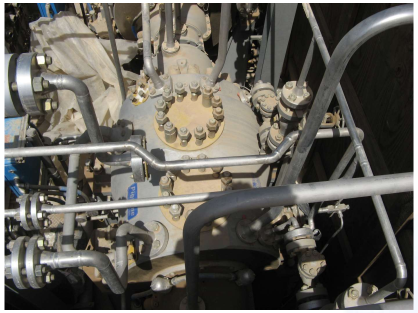
TRAINING PROJECT ,SPECIFIC COURSE

Injection gas compressor (Working principle)





Prepared by: Benny



Course Objectives

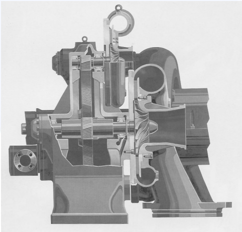
Up on completion of this course participants should be able to:

- **Identify all kind of compressors and their systems**

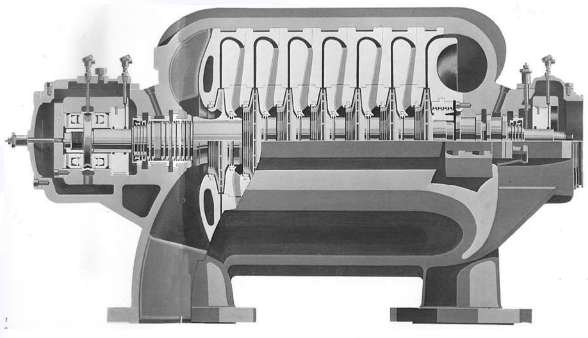
- **Get familiar with GE gas compressors and their classification**

Compressor Overview

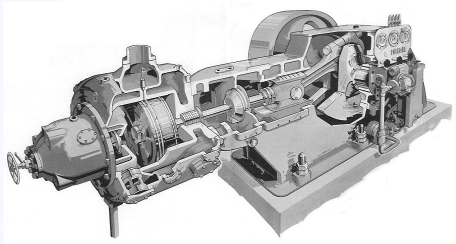
Compressors are one of the most important members of industrial plants in any field .They can be used



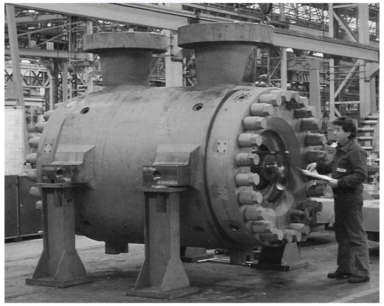
- To generate compressed air



- To build up the process gas as per processes requirement
  (gas .oil .petrochemical and other process purposes)

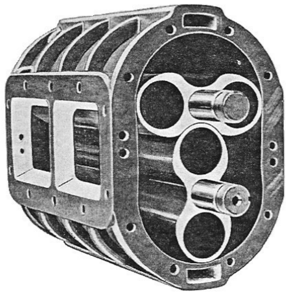


- To increase gas pressure for injection purposes.



- To increase the pressure for gas handling application (in gas station)

- To use for refrigeration or cooling application



Compressor Overview

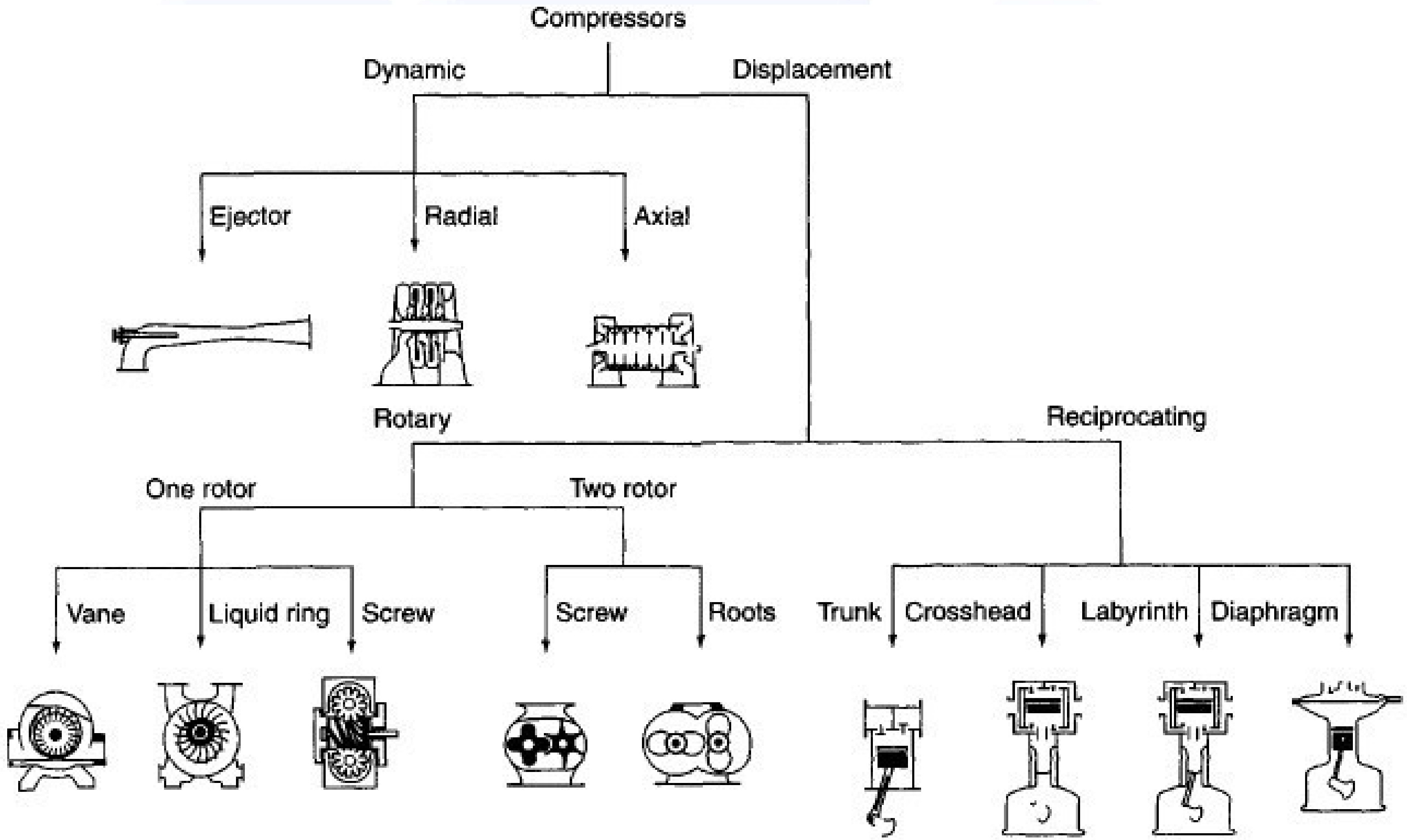
Most used compressor classifications

- Compressors
  - Positive displacement machine
    - Reciprocating compressors
    - Rotary vane compressors
    - Screw compressors
  - Turbocompressors
    - Centrifugal compressors
    - Axial-flow compressors

	Reciprocating compressors	Rotary vane compressors	Screw compressors	Centrifugal compressors	Axial-flow compressors
Compression	Volume			Conversion of kinetic energy	
Motion	Reciprocating	Rotating		Rotating	
Delivery	Intermittent	Quasi-continuous		Continuous	
Volume flow	Low	Low	Low/medium	Low/high	Very high
Compression ration	High	Medium		Medium	Low
Operation	Constant volume — Variable pressure			Variable volume — Quasi-constant pressure	
Principle					
Function of a compressor	To render a specific volume of gas from a given initial condition into a desired final condition (pressure/temperature).				

Compressor Overview

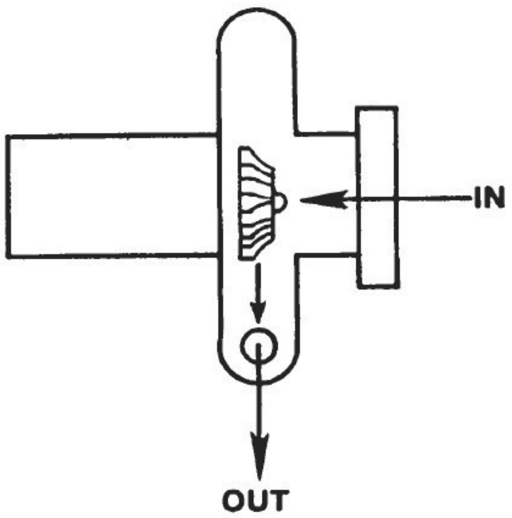
Other types of compressor classifications

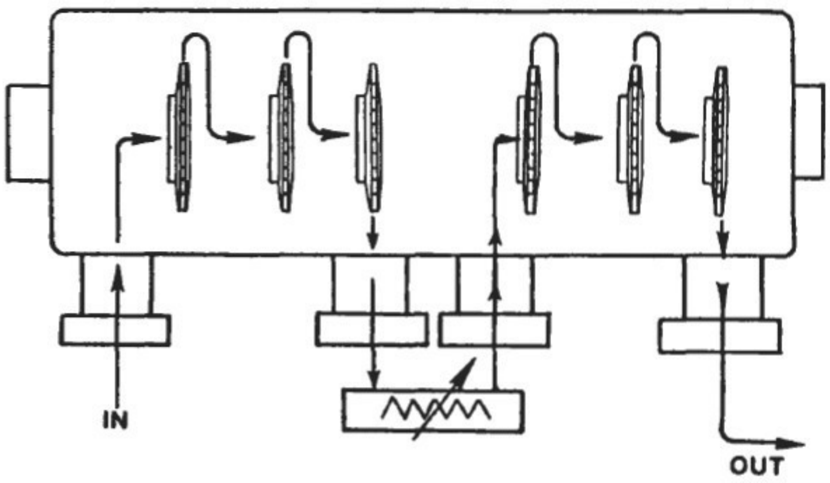


Dynamic compressors

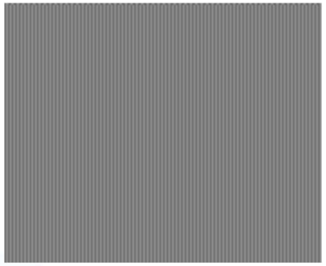
Dynamic compressors are rotary continuous-flow machines in which the rapidly rotating element accelerates the gas as it passes through the element, converting the velocity head into pressure, partially in the rotating element and partially in stationary diffusers or blades.

The capacity of a dynamic compressor varies considerably with the working pressure.



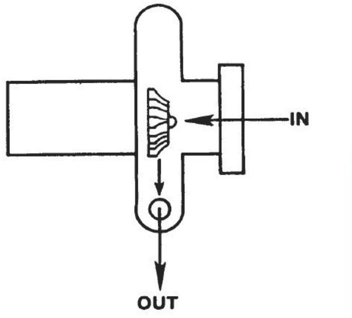


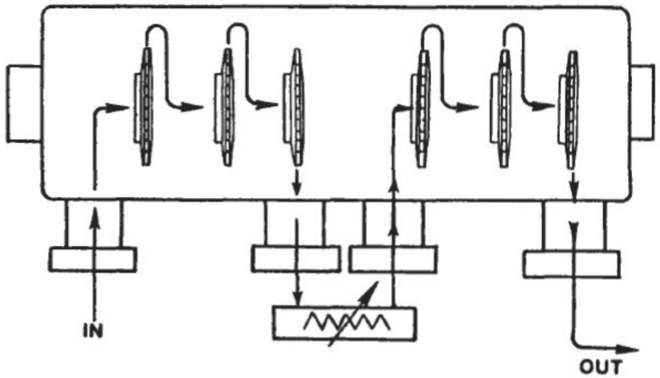
Compressor Overview



Centrifugal compressors

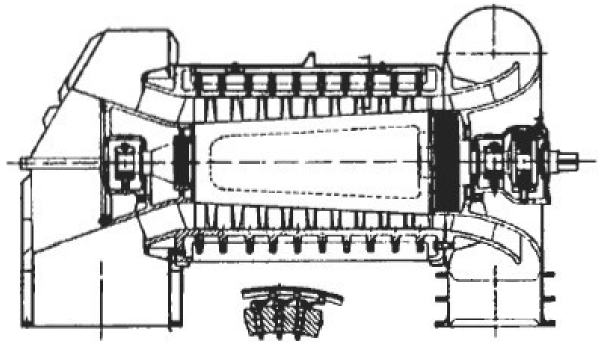
Acceleration of the air/gas is obtained through the action of one or more rotating impellers; non-lubricated; the discharge air/gas is free from pulsation; very high rotational speed.





Axial compressors

Acceleration of the air/gas is obtained through the action of a bladed rotor, shrouded at the blade ends; non-lubricated; very high rotation speed; high volume output with low discharge pressure.

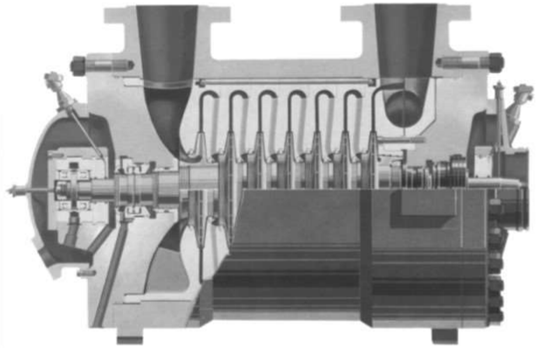


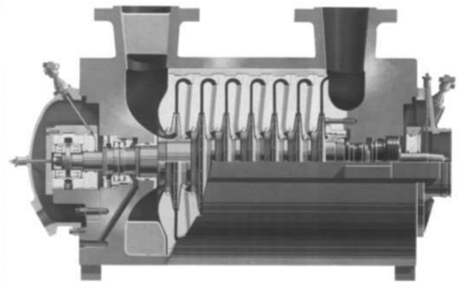
Compressor Overview

Turbo compressors

Turbo compressors (also referred to as centrifugal compressors), like gyro pumps, use the dynamic operating principle; i.e. they generate static pressure by converting kinetic energy into static pressure energy. Impellers that rotate at high speed provide the energy-transmitting element.

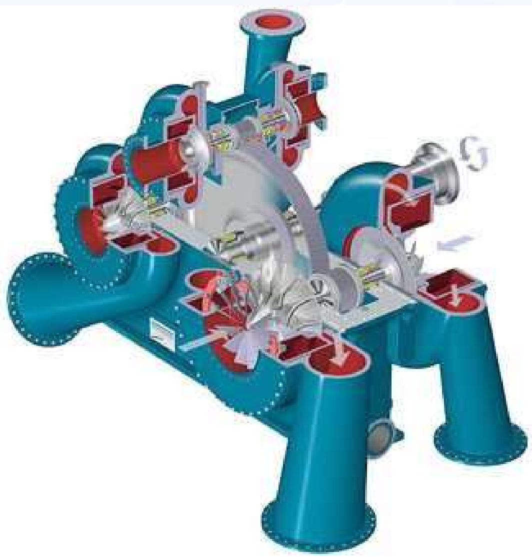
Such compressors are described as either radial or axial depending on the impeller form.

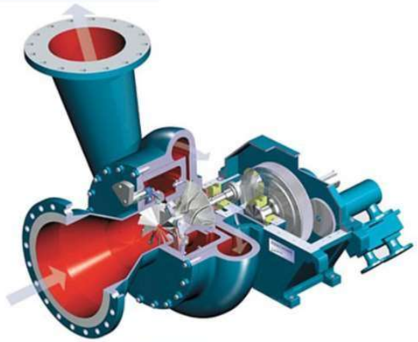




Turbo compressors are used in:

- Air separation plants
- Pressure separation plants
- Chemical and petrochemical processes
- Coal gasification
- Refining
- Natural gas production and transport
- Crude oil production
- Refrigeration circuits
- Heat recovery systems
- Steelworks
- Hydrogen production
- Flue gas desulphurisation plants
- Gas turbine compressors

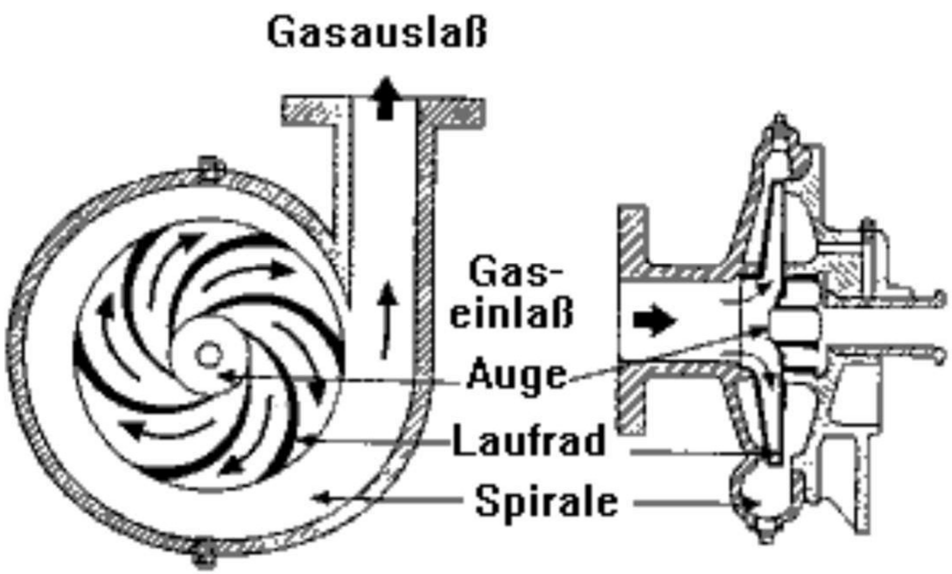




Compressor Overview

Turbo compressors of radial design

Radial turbo compressors are suitable for medium gas delivery rates. In these, gas is taken in at the impeller inlet and accelerated by centrifugal force in the nozzle-like, narrowing compartments of the impeller.
At the circumference of the impeller, the gas exits the compartments of the impeller at high speed and flows into the widening, radial diffuser and, from there, into the spiral collecting tube.
Here, it changes direction continuously and is rapidly slowed. The kinetic energy released during this phase is converted into static pressure energy, so that the static pressure rises suddenly.
The compressed gas current exits the compressor through the pressure pipe.

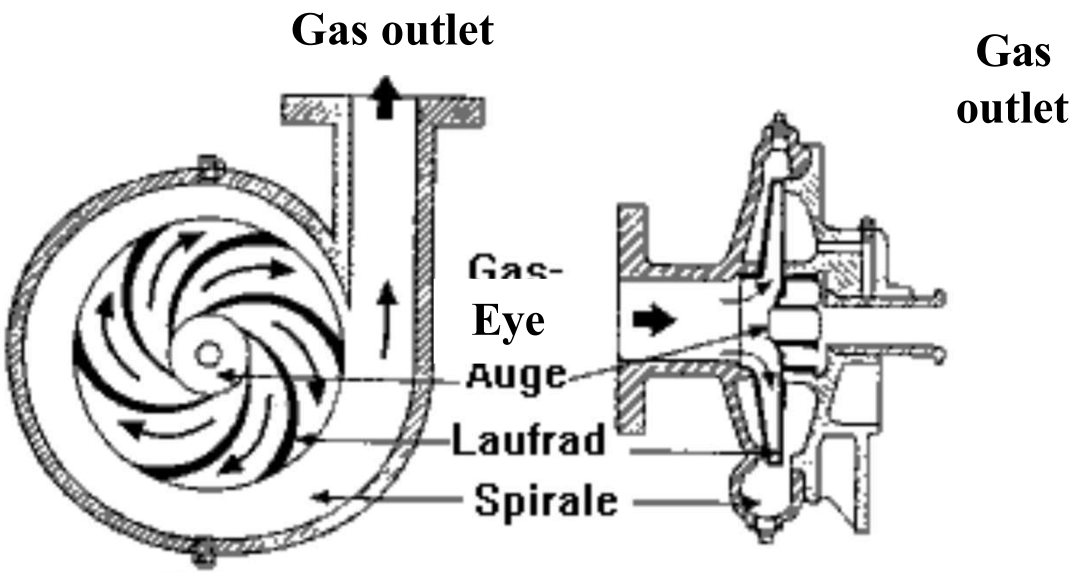


Compressor Overview

The pressure ration p2/p1 of single-stage radial turbo compressors is 1.3 to 3.
They deliver a consistent, oil-free pressurised gas current.

By arranging several impellers one after the other on one drive shaft, it is even possible to generate medium-high and very high pressures. In this case, the gas compressed in the first impeller is fed via a collecting pipe and an inter-cooling circuit to the second impeller, etc.

A four-stage radial turbo compressor typically has a final pressure of 8 to 10 bar. The use of an inter-cooling circuit after each impeller reduces power consumption.
They are used in the chemical industry for compressing process gas, for example.
Radial turbo compressors are grouped into single and multistage single-shaft machines and gear compressors, depending on pressure and delivery rate.



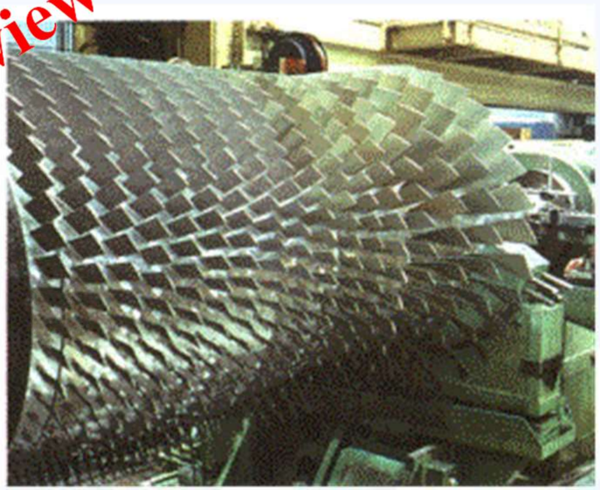
Turbo compressors of axial design

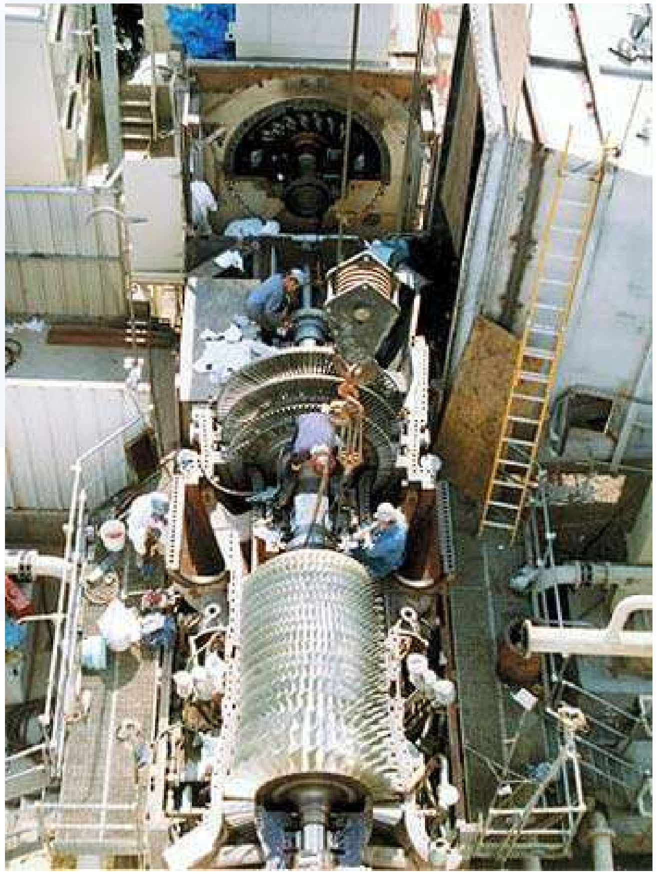
Turbo compressors with axial impellers deliver the largest flow rates of up to 1,000,000 m3 /h. They are used in natural gas liquefaction plants, for example. Axial compressors are always multistage.

An axial compressor stage is the inverse of a reaction stage of a steam turbine. The impeller comes before the stator and generates a high speed that is converted into pressure in the stator.

Due to the necessary flow channels, the blade profile is significantly thinner than in steam turbines. Since a delayed flow separates more easily, the number of stages must be greater than in a turbine. Typical gas turbines have, for example, 16 (compressor) and 4 (turbine) stages.

Axial compressors are generally designed without inter-coolers.

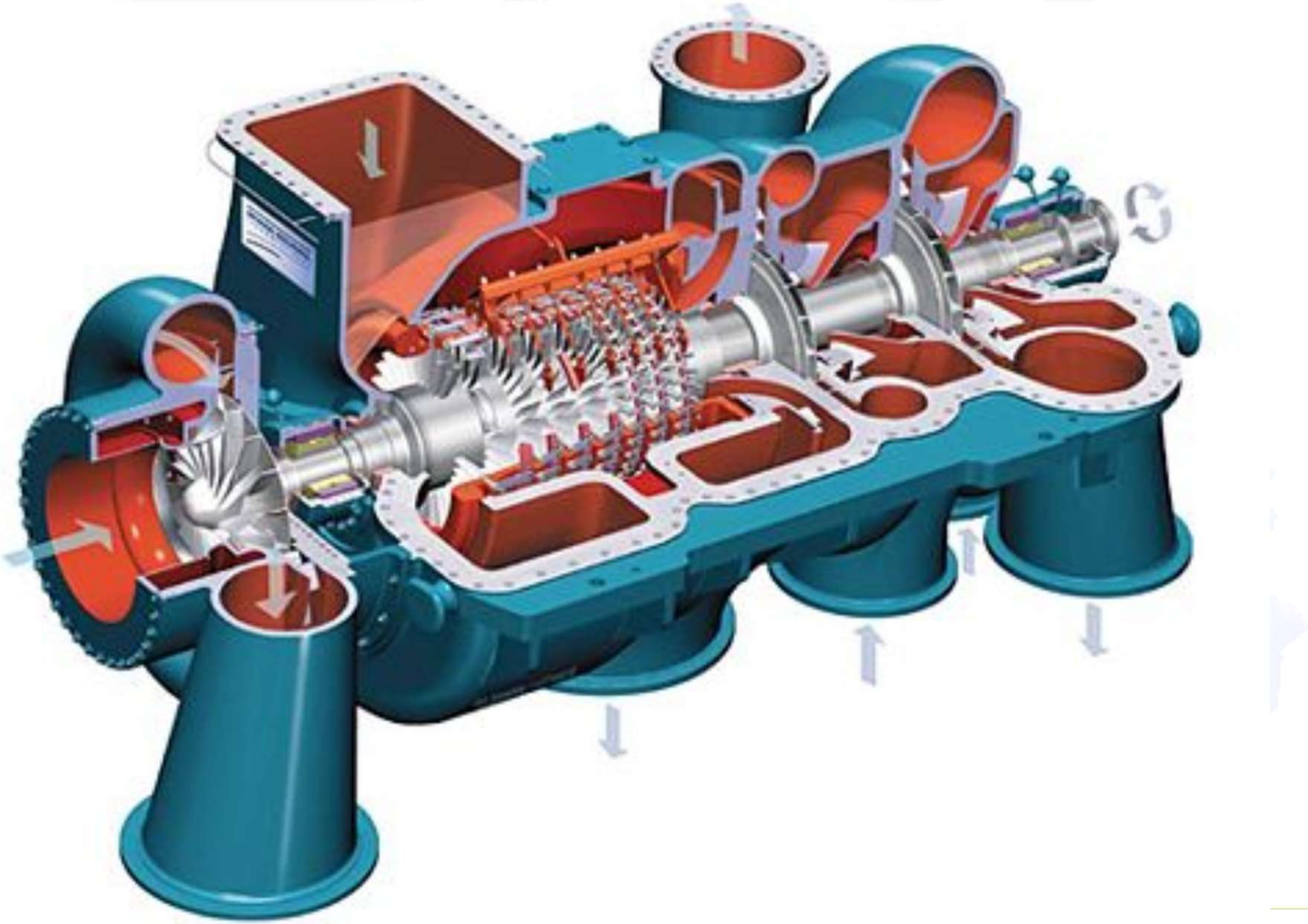




The following performance figures can be achieved:
Stage pressure ratio up to 0.6 bar
Efficiency up to 0.9

Compressor Overview

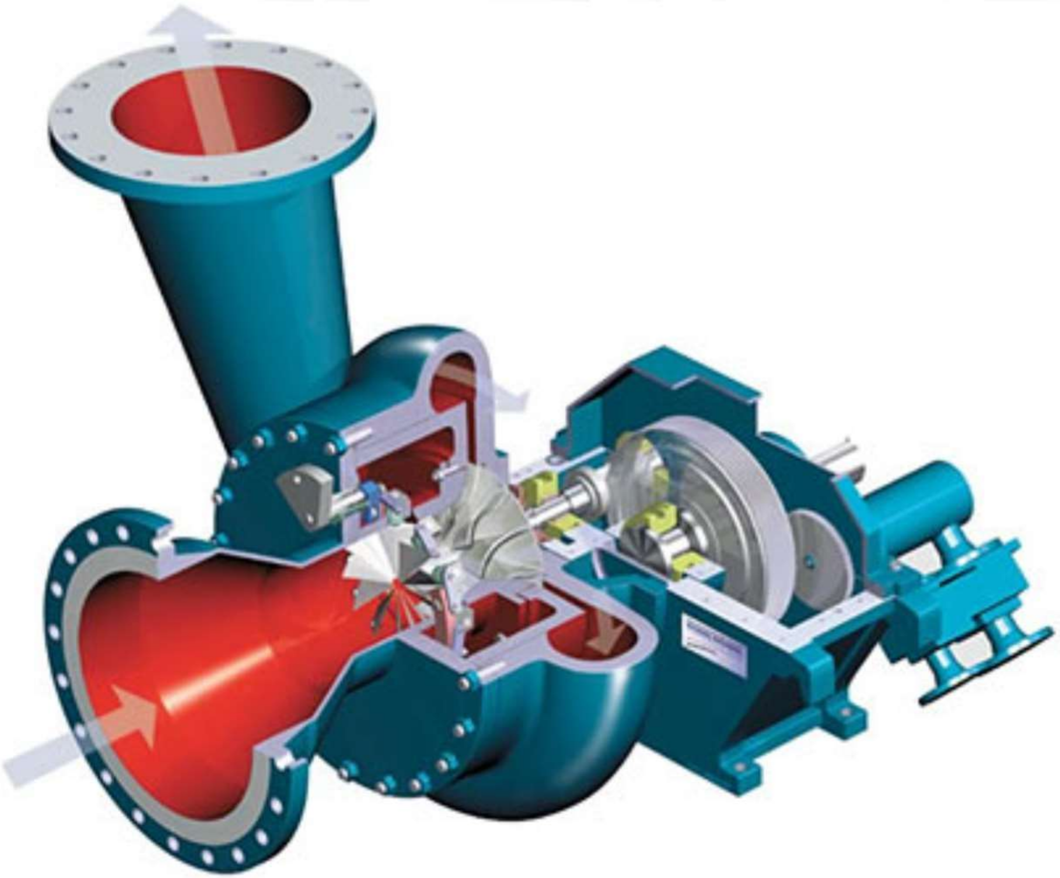
The combined type takes account of the thermal conditions, combines the advantages of both types and avoids the over-large construction of the radial compressor because the gas already has a smaller volume.

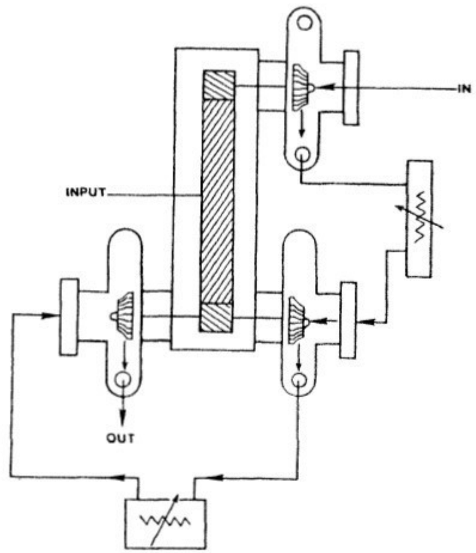


Compressor Overview

Gear compressors

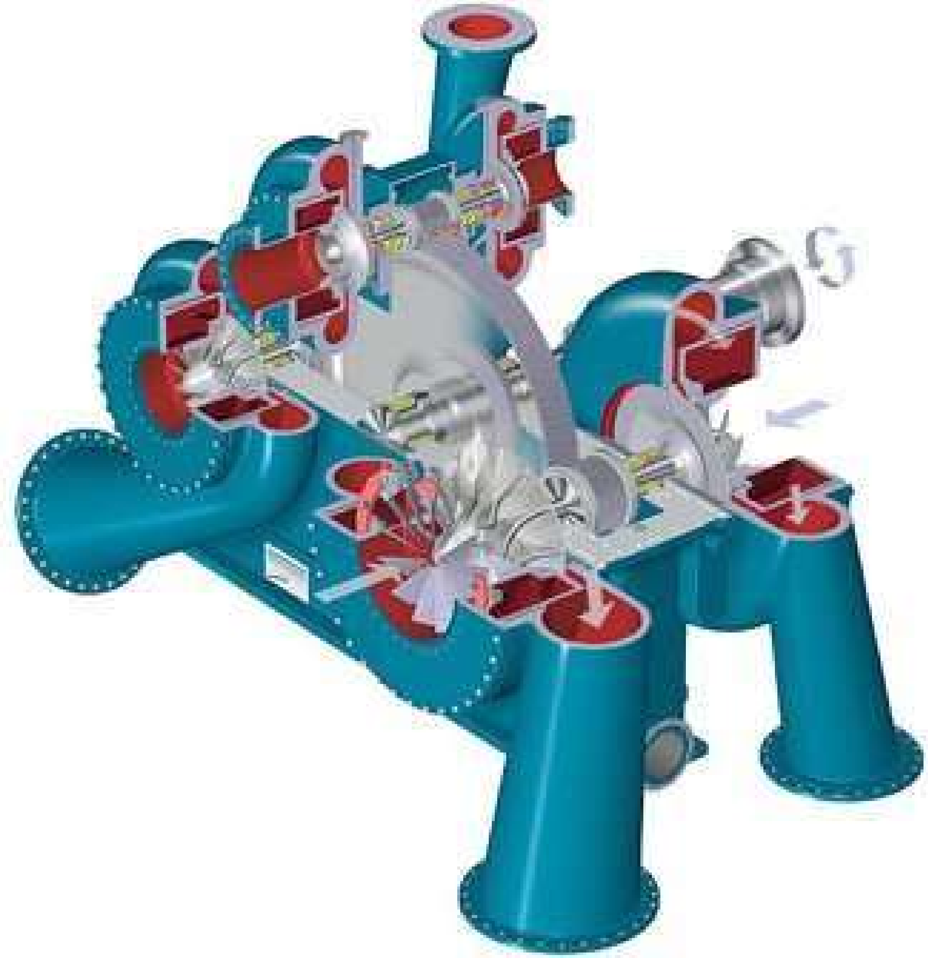
The impeller of a gear compressor is mounted overhung on a high-speed pinion shaft of a gear drive.
By flanging the associated spiral housing to the gear casing, the unit is compact and can be mounted on a base plate together with the drive unit and the lube oil supply.
A baffle unit mounted upstream of the impeller permits satisfactory efficiency under partial load.
The seal unit sits immediately behind the impeller. The pressure to be sealed corresponds to the suction pressure plus 60% of the pressure differential between the suction and the final pressure.

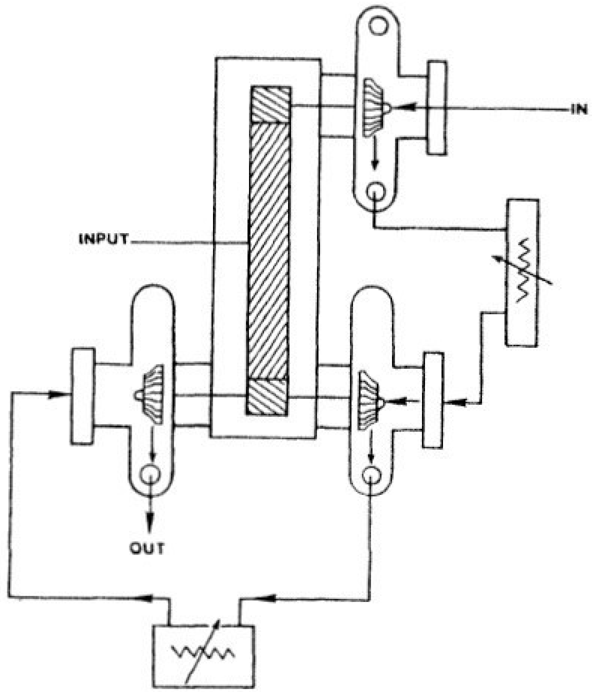




Multistage gear compressors

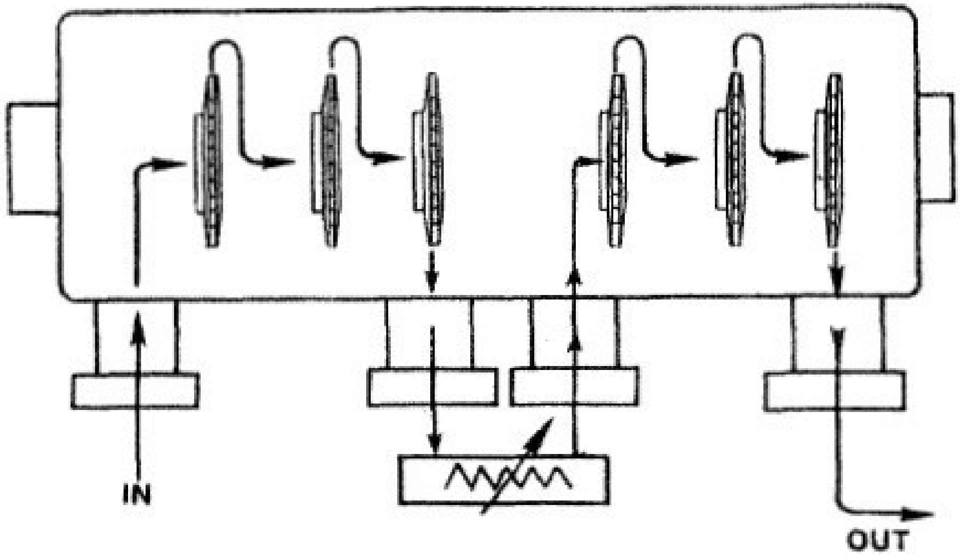
Multistage gear compressors have pinion shafts arranged around the central drive wheel, which carry an overhung impeller at the ends.
The advantage of this design is that each stage can be given a different speed.



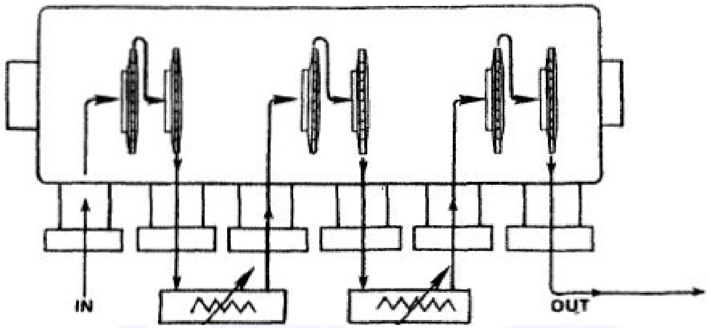


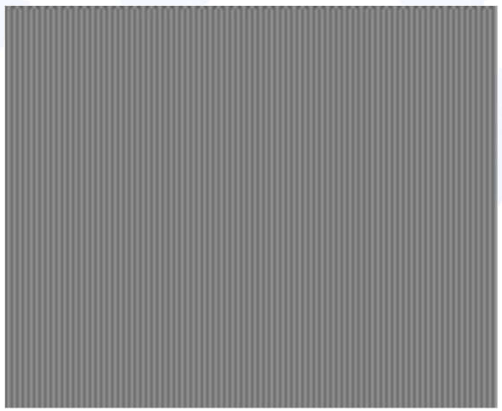
Compressor Overview

Diagram of a multistage centrifugal compressor with a straight-through flow path, Figures 5-9 and 5-10 depict the two most common forms of in-out arrangements.
This arrangement is also referred to as a compound compressor.
In these applications, the flow out of the compressor is taken through an intercooler and back to the compressor. The arrangement is not limited to cooling because some services use this arrangement to remove and scrub the gas stream at a particular pressure level.
Provision for liquid removal must be made if one of the gas components reaches its saturation temperature in the process of cooling.



5-9





Compressor Overview

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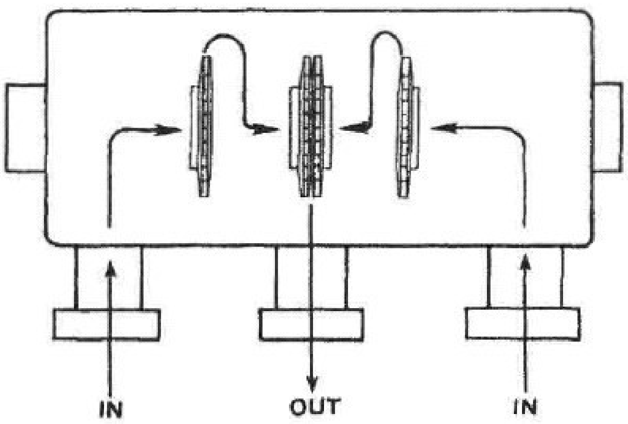
The arrangement shown in below Figure is referred to as a double-flow compressor.
As indicated in the figure, the flow enters the case at two points, is compressed by one or more stages at each end, and then enters the double-flow impeller. The flow passes through each individual section of the double-flow impeller and joins at the diffuser.

There are various physical arrangements to accomplish the double-flow compression. One variation is to use two back-to-back stages for the final compression and join the flow either internally, prior to leaving the case, or join two separate outlet nozzles outside the case.



Compressor Overview

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Another variation of this arrangement is to use it in the single-stage configuration, where only a single inlet and outlet nozzle is used.. The flow enters the case and is divided to each side of the double-flow impeller and then joins at the impeller exit prior to entering the diffuser. following Figure shows a schematic diagram of the flow in this machine.

DOUBLE FLOW

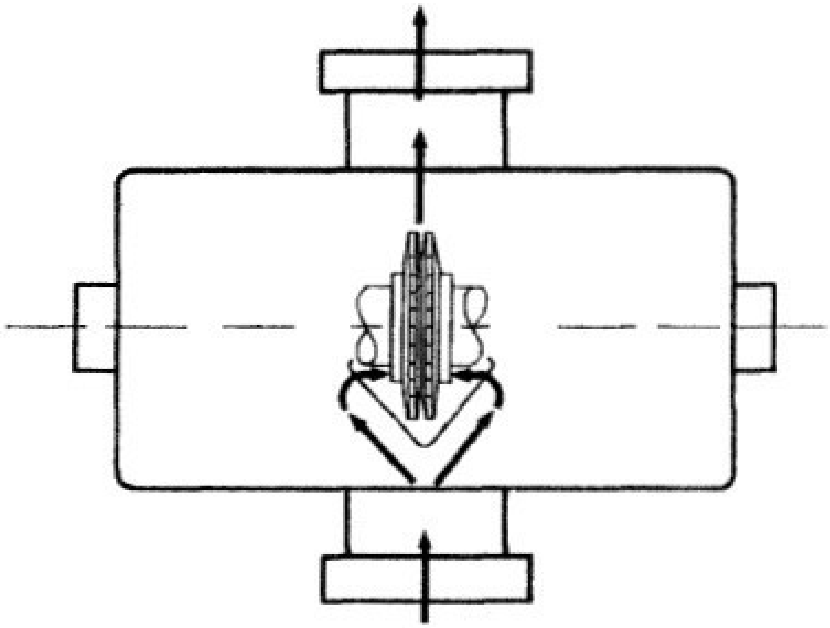


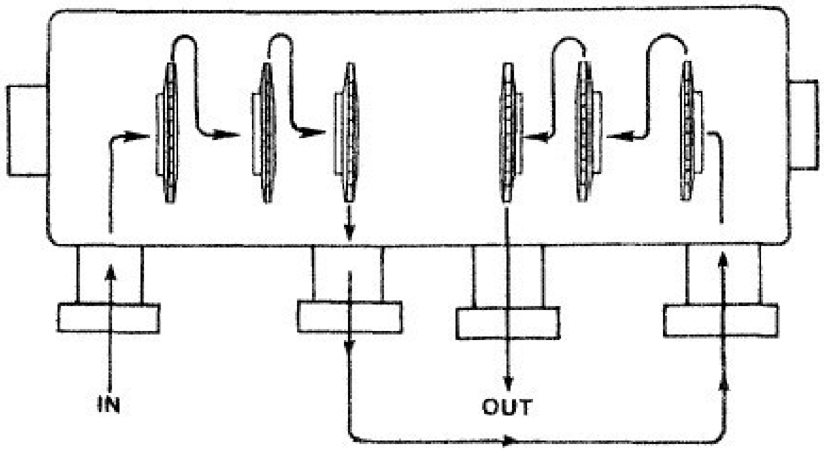
Figure 5-13. Diagram of a double-flow compressor with flow split internally.

The arrangement in Figure 5-14, generally called "back to back," is normally considered useful in solving difficult thrust balance problems where the conventional thrust bearing and balance drum size are inadequate or become excessively large.

The flow is removed part way through the compressor and reintroduced at the opposite end, then allowed to exit at the center.
Because centrifugal impellers inherently exhibit a uni-directional thrust, this arrangement can be used to reduce the net rotor thrust.

The obvious use is for applications generating high thrusts, higher than can be readily controlled by a normal size thrust bearing and balance drum. An evaluation of the cross leakage between the two discharge nozzles must be made and compared to the balance drum leakage to determine the desirability of the "back to back."
It can be combined with the side stream modes, discussed in the next paragraph, to possibly help sway close evaluation. In some rare cases, this design has been used for two different services. Unfortunately, it is difficult to totally isolate the two streams because of the potential cross leakage. In cases where the two services may have a common source or the mixing of the streams does not cause a problem, it is possible to generate savings by using only one compressor case.

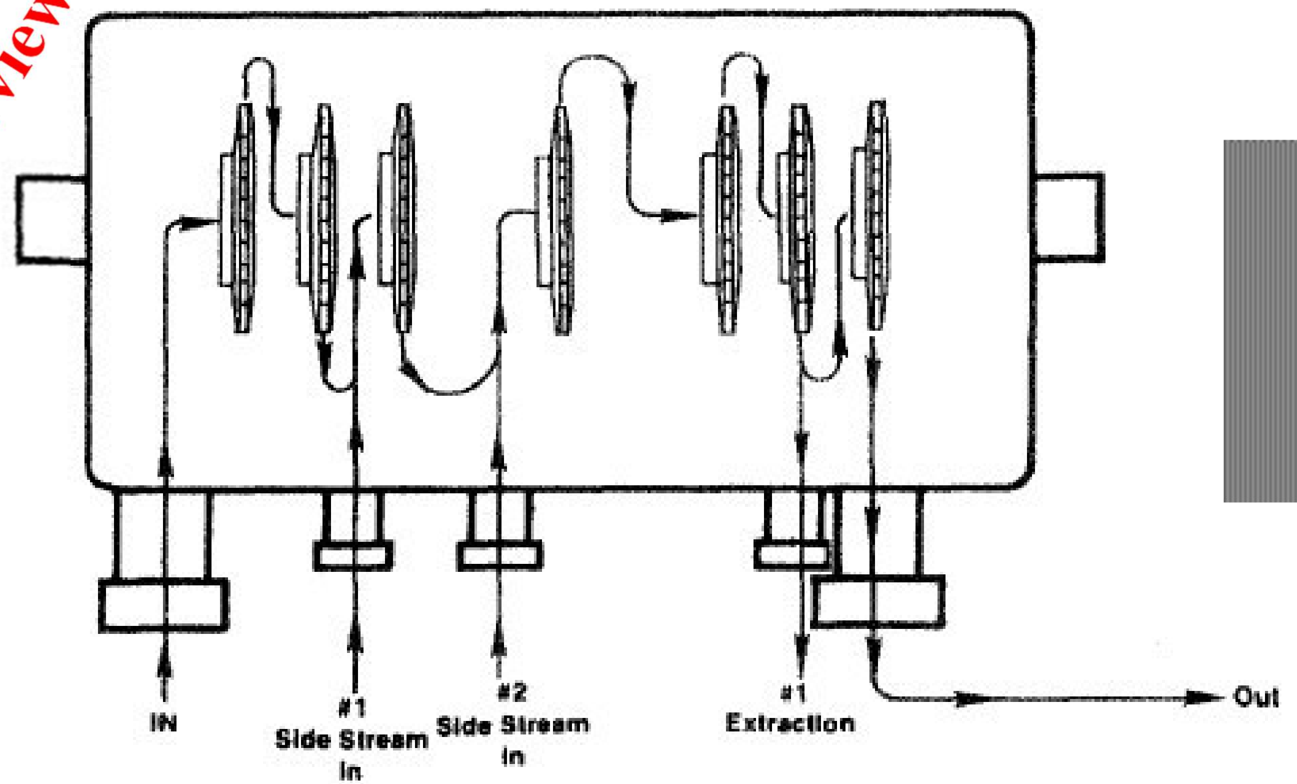
BACK TO BACK

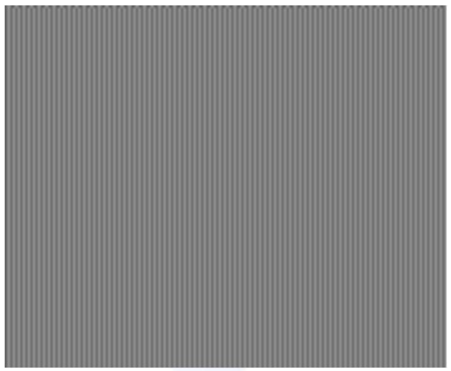


SIDE STREAM

A very common compressor design used in the oil and gas industry, particularly in large refrigeration systems, is the *sidestream* compressor (see Figure 5-15).
Gas enters the first impeller and passes through two impellers. As the main stream approaches the third impeller, it is joined by a second stream of gas, mixed, and then sent through the third impeller.
The properties of the gas stream are modified at the mixing point, as the side-stream is rarely at the same temperature as the stream from the second impeller. In refrigeration service, this stream is taken from an exchanger where it is flashed to a vapor, resulting in a stream temperature near saturation. As such, the side stream would act to cool the total stream.

Compressor Overview

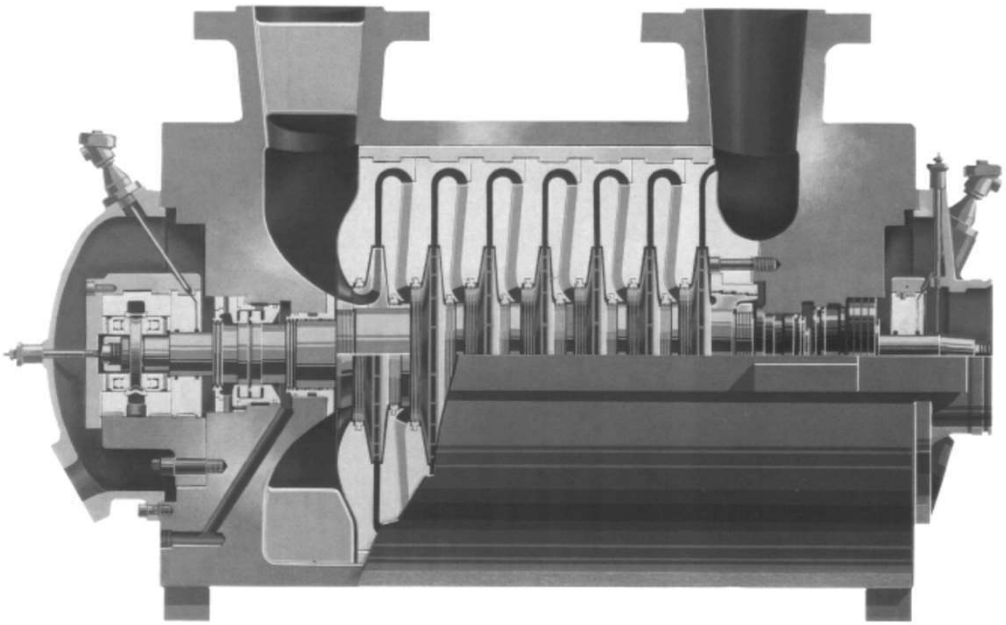




Single-shaft compressors

An arrangement of several impellers on one shaft is traditional for radial compressor construction.

The gas to be conveyed is delivered radially outwards and thence via deflecting ducts back to the inside of the next stage.
The same pressure acts on the two sides of the impeller, i.e. the front and back. Since their surfaces are significantly different, an axial thrust is generated that pushes the rotor towards the suction side.
A specially designed pressure compensation system, consisting of a pressure compensation piston and pipe, counteracts approx. 95% of the axial force

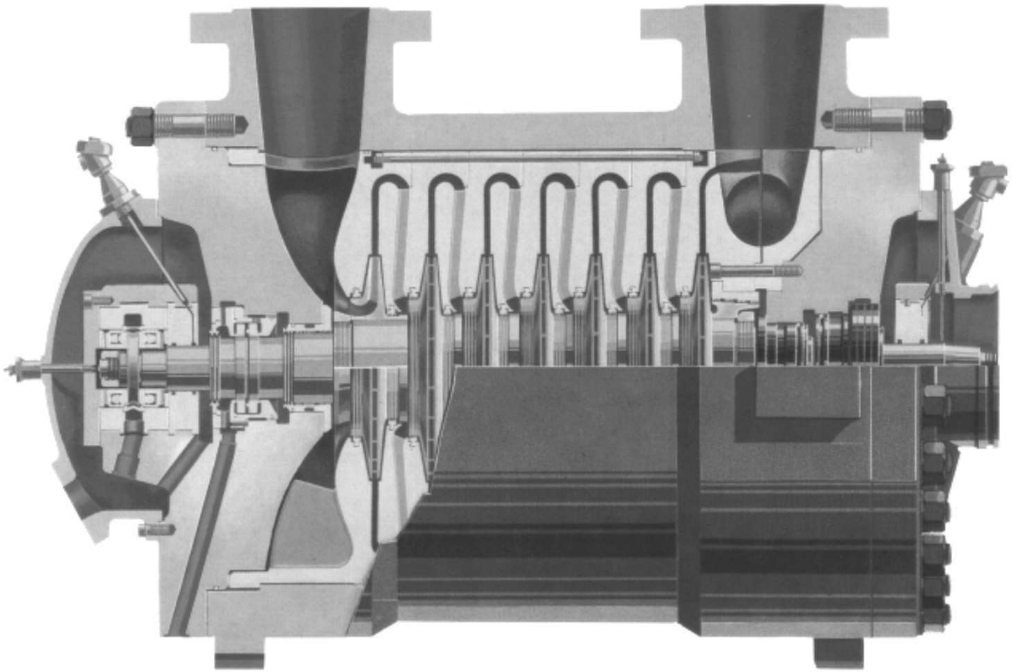


The bearing absorbs the remaining axial force. Single-shaft compressors are sealed both on the suction and the pressure side. Due to the compensating system, the pressure to be sealed off corresponds to the suction pressure of the machine.

Barrel-type compressors

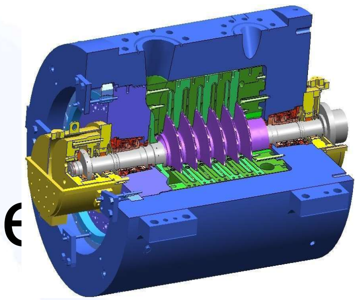
Barrel-type compressors are used for gases of small molecular mass (in horizontally split compressors, this is diffused through the joint) and high pressures (> 70 bar abs).

They have a cylindrical housing with end covers.
The internal fixed unit is split horizontally; it is pre-assembled with the rotor and the resultant unit is inserted lengthwise into the barrel-like outer casing.



Ways a centrifugal compressor raises pressure

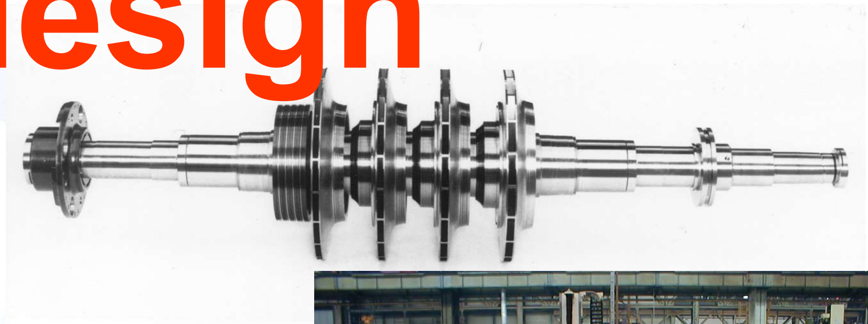
- Centrifugal forces through impeller
  - gas accelerated from eye to tip of impeller
- Aerodynamic forces
  - gas moving across impeller blades
  - gas accelerated from eye to tip of impe



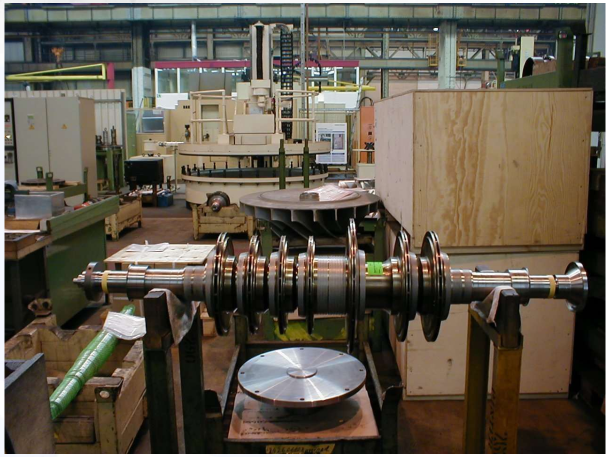
- Converting kinetic energy to pressure

  gas slowing down through the diffuser

Rotor design

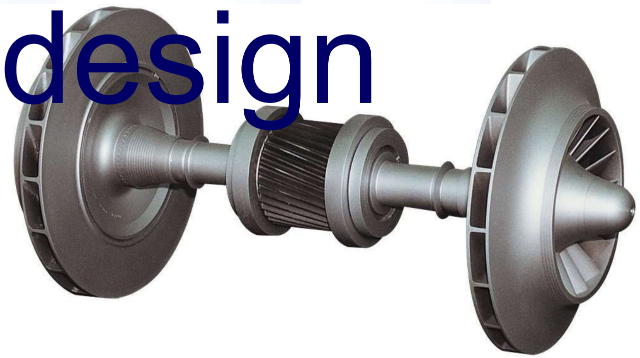


1 - Inline design

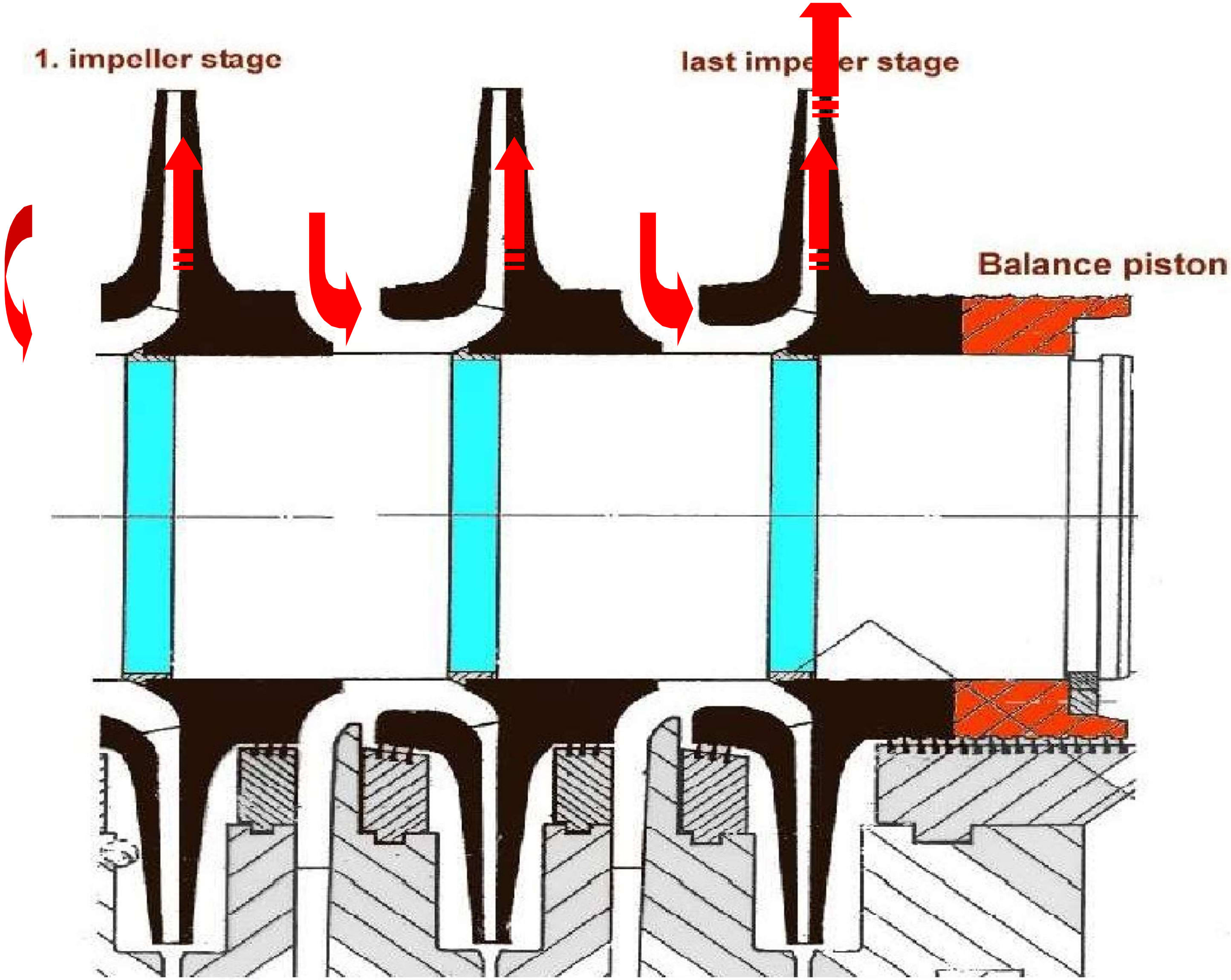


2 - Back to back design

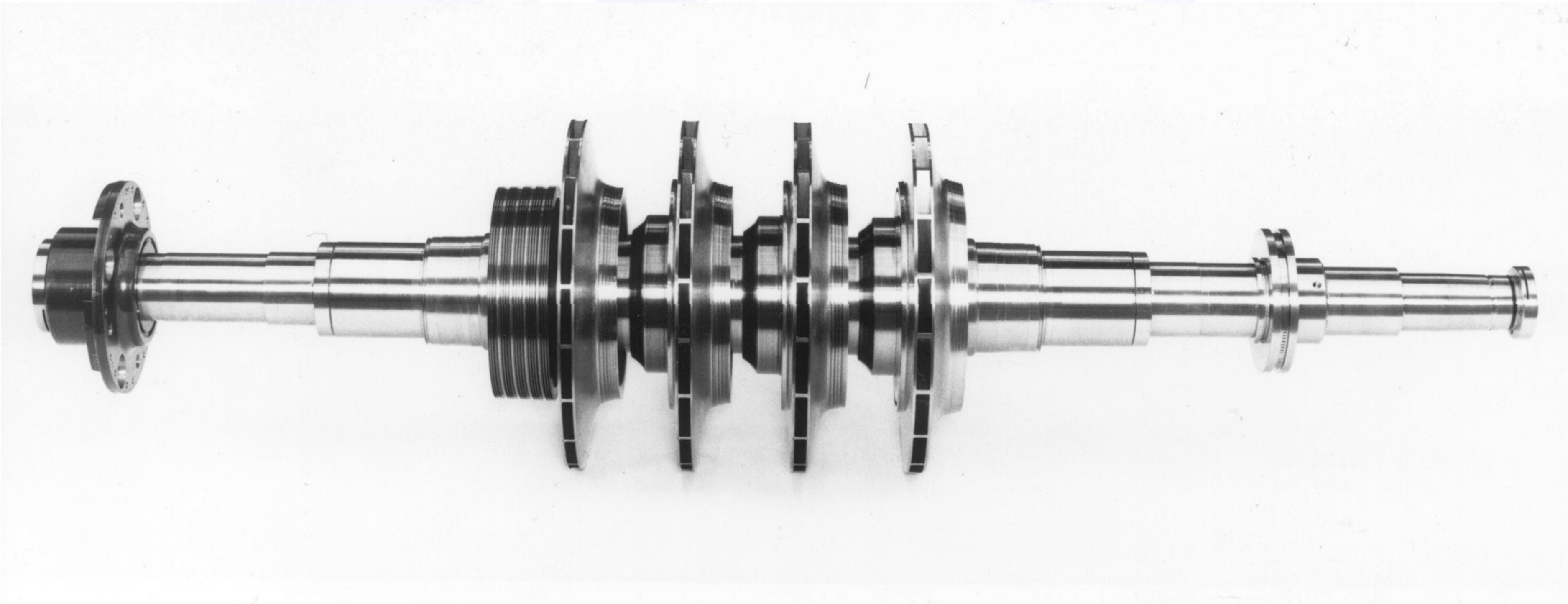
3 - Overhanging design



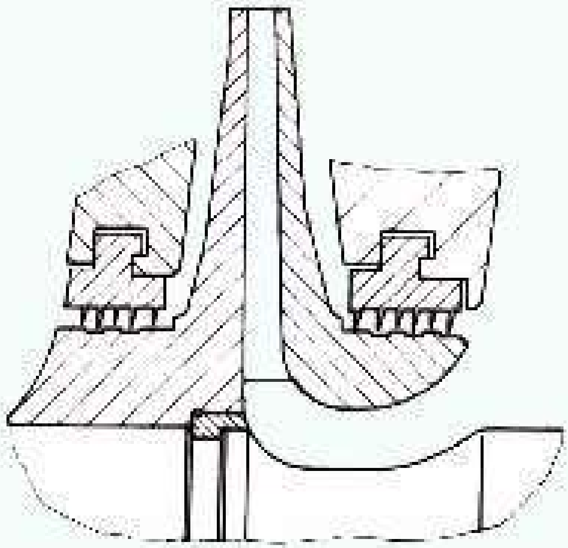
Rotor - inline design -

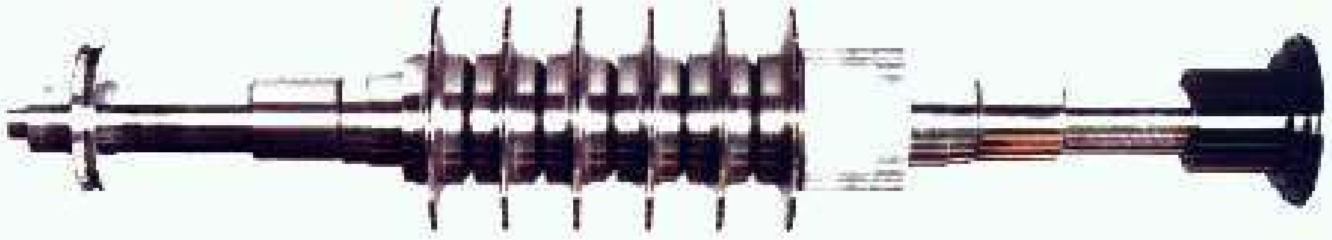


Rotor Inline Design

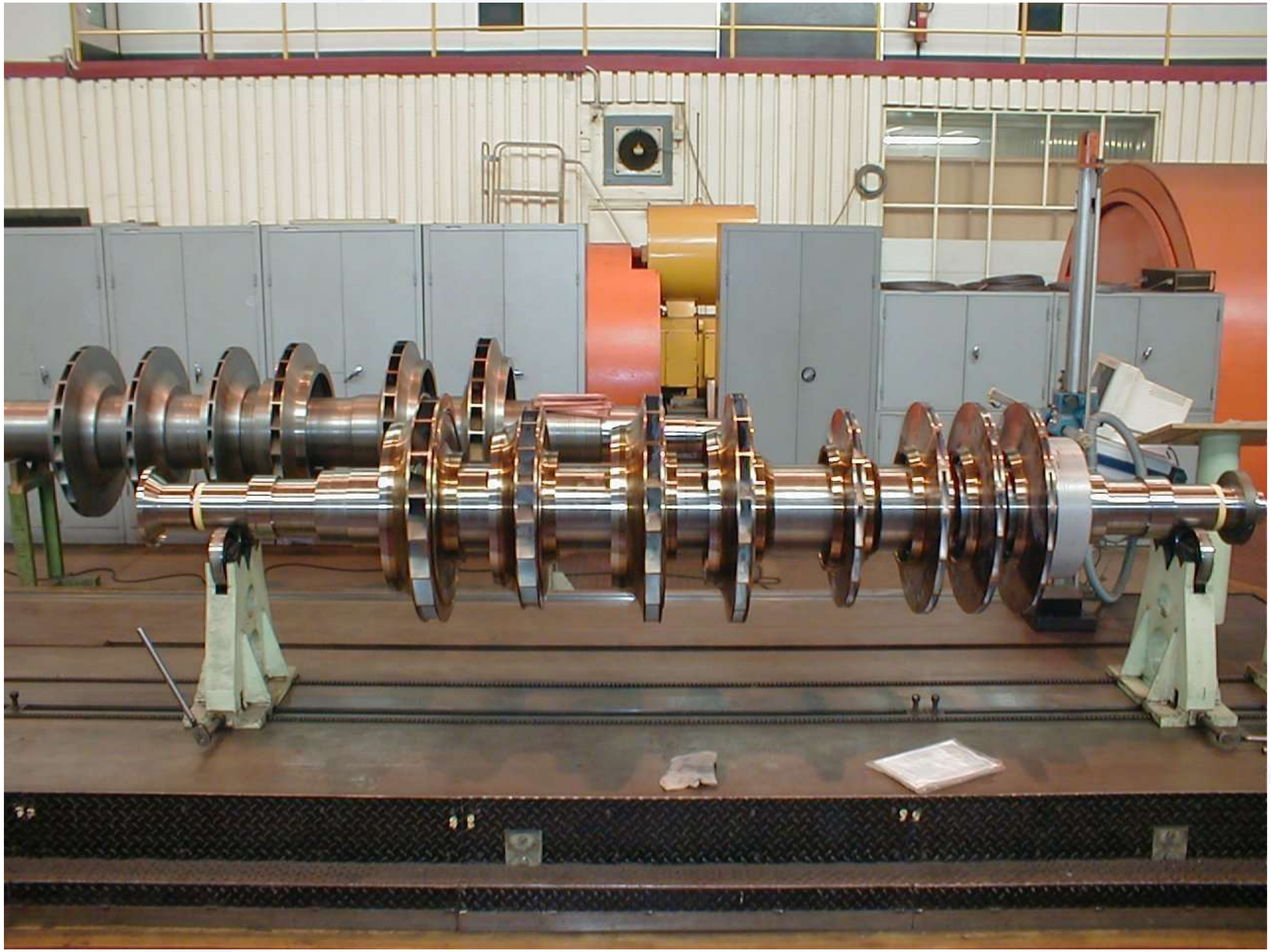


Rotor Inline Design

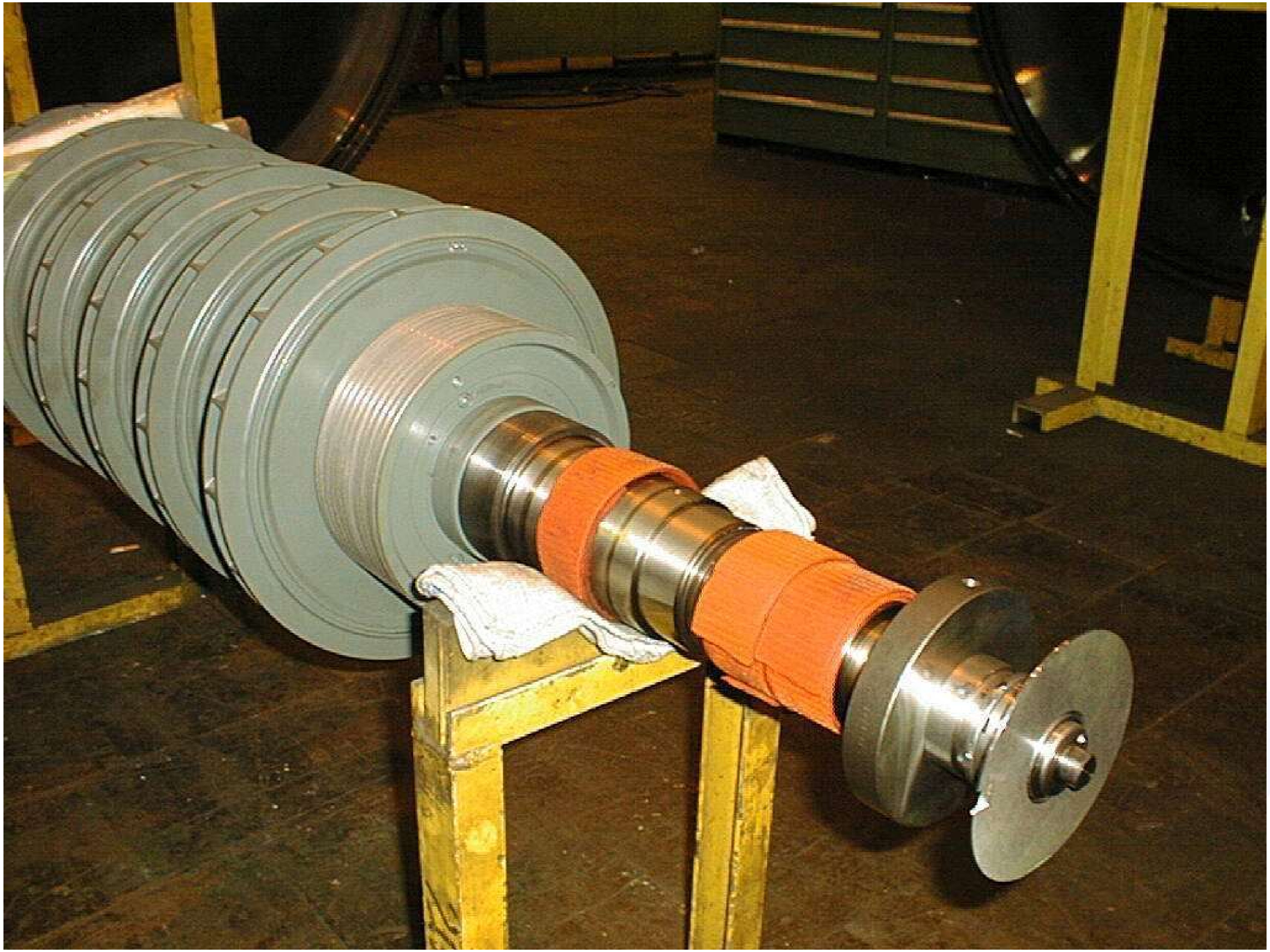




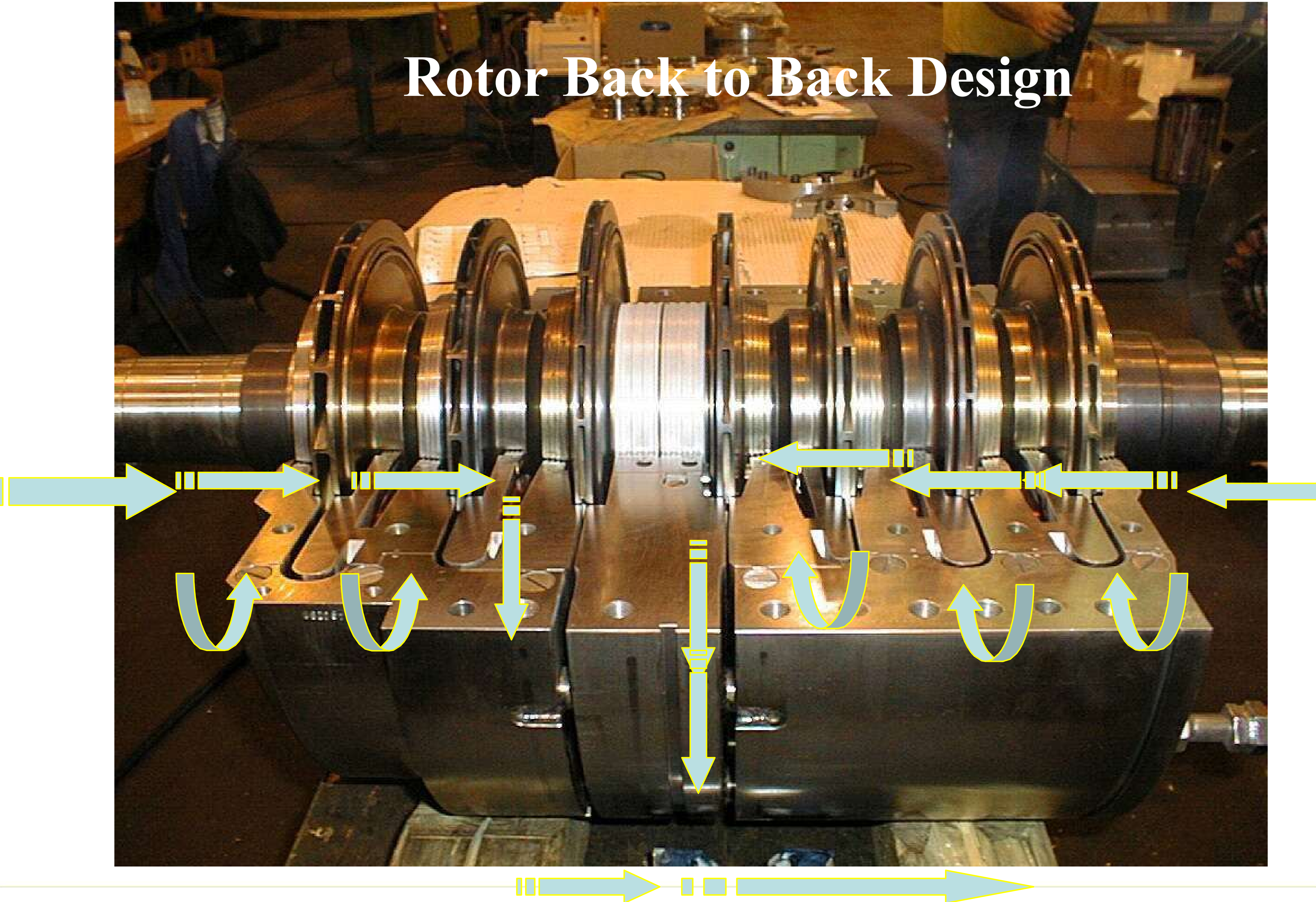
Rotor Inline Design



Rotor Inline Design



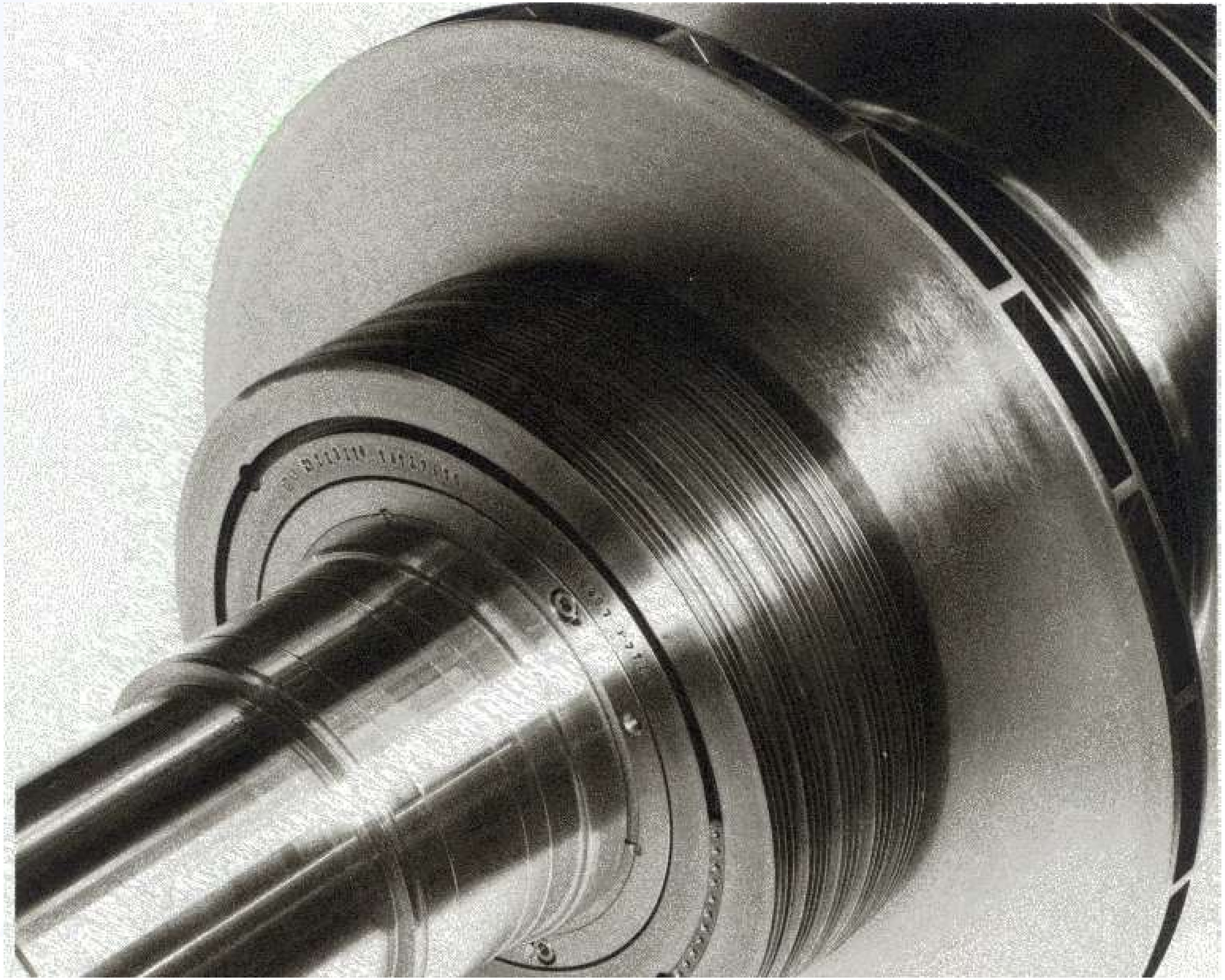
Rotor Back to Back Design



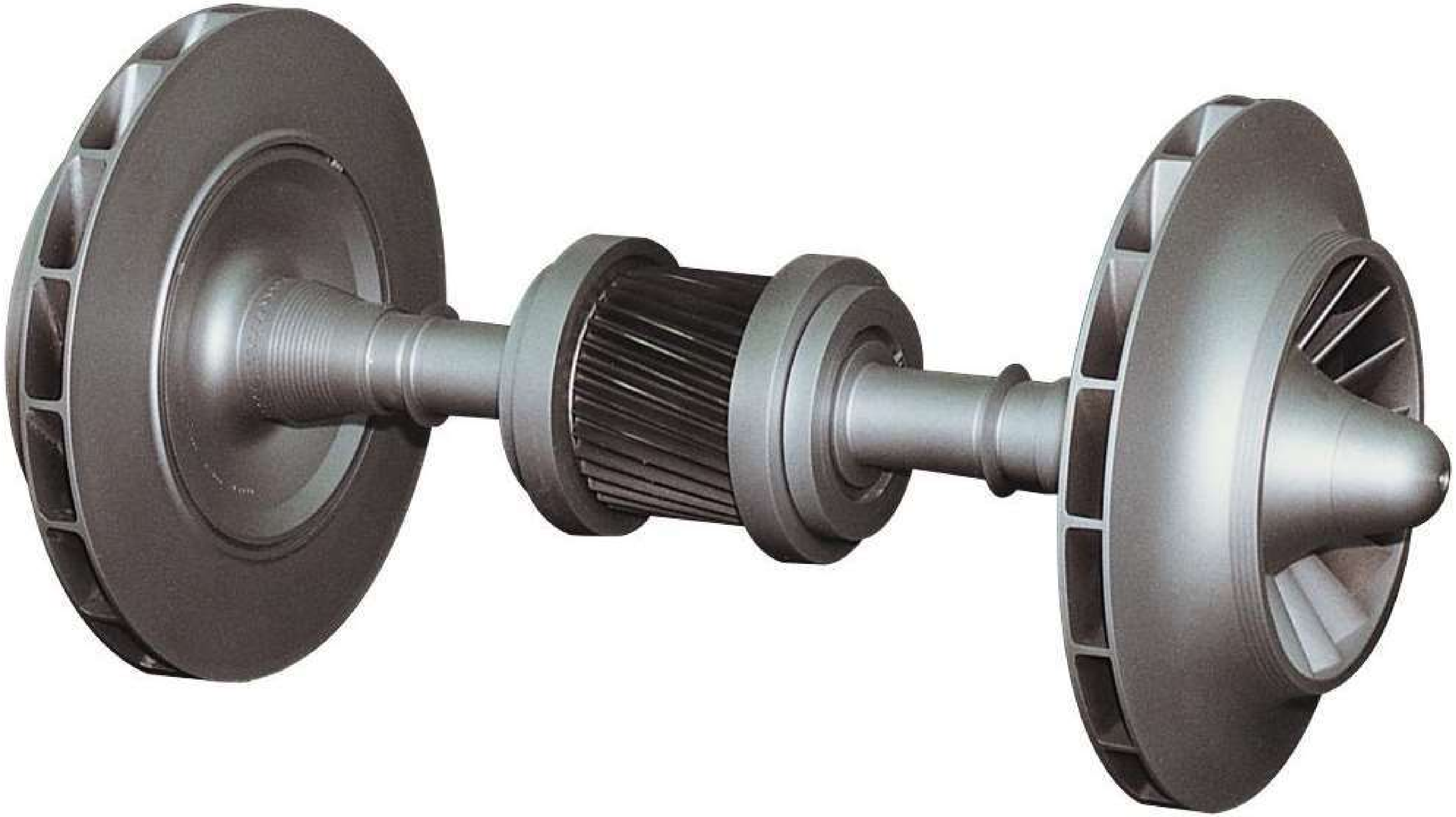
Rotor Back to Back Design

Balance Drum on rotor

BALANCE PISTON



Rotor Overhang Design



Rotor Overhang Design

Vendors Classification (as per compressor configuration)

NUOVO PIGNONE'S RANGE OF CENTRIFUGAL COMPRESSORS

The centrifugal compressors have different configurations to suit specific services and pressure ratings.They may be classified as follows:

COMPRESSORS WITH HORIZONTALLY-SPLIT CASINGS
COMPRESSORS WITH VERTICALLY-SPLIT CASING
COMPRESSORS WITH BELL CASING
SR COMPRESSORS

COMPRESSORS WITH HORIZONTALLY-SPLIT CASINGS

Horizontally- split casings consisting of half casings joined along the horizontal center -line are employed for operating pressures below 60 bars.

The suction and delivery nozzles as well as any side stream nozzles, lube oil pipes and all other compressor- plant connections are located in the lower casing.

With this arrangement all that is necessary to raise the upper casing and gain access to all internal components, such as the rotor, diaphragms and labyrinth seals is to remove the cover bolts along the horizontal center-line

The horizontally –split casing compressors are indicated by the letter designation MCL and may be further identified according to the number of stages.

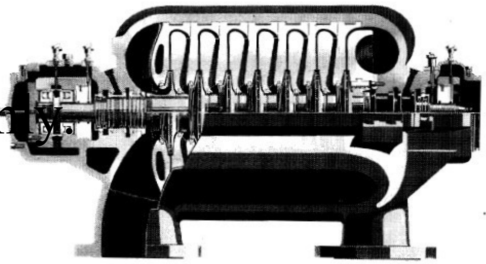
- •MCL Compressors
- •2MCL Compressor
- •3MCL Compressor
- •DMCL Compressor

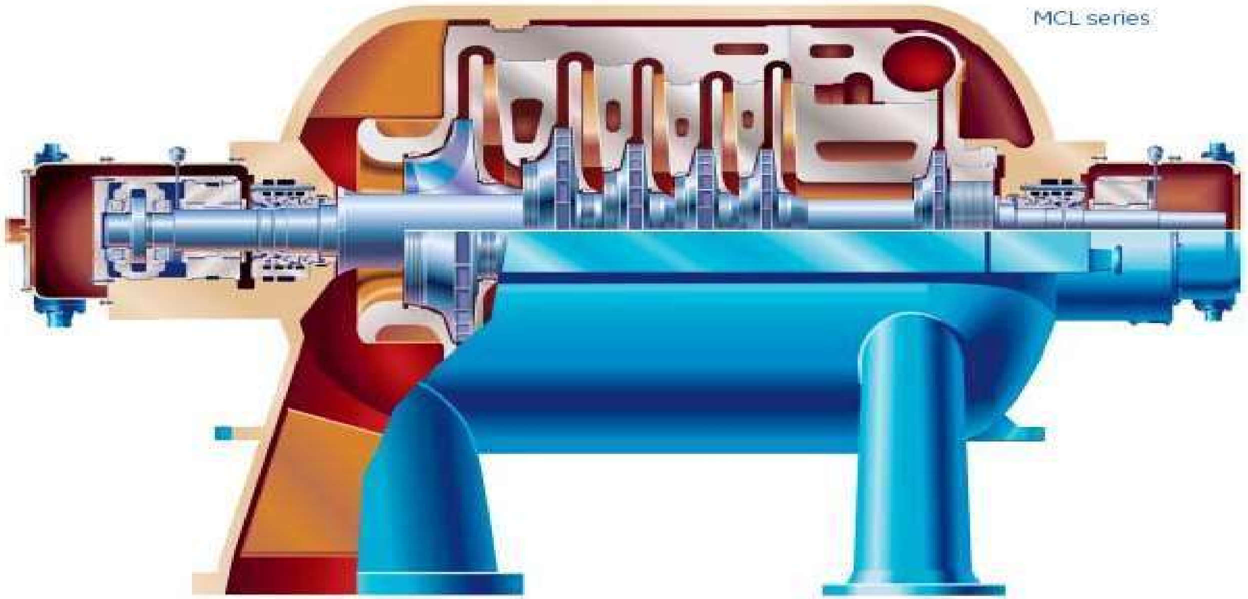
2MCL Horizontally split compressor being machined

Horizontally –split casings fall into the following groups:

MCL Compressors

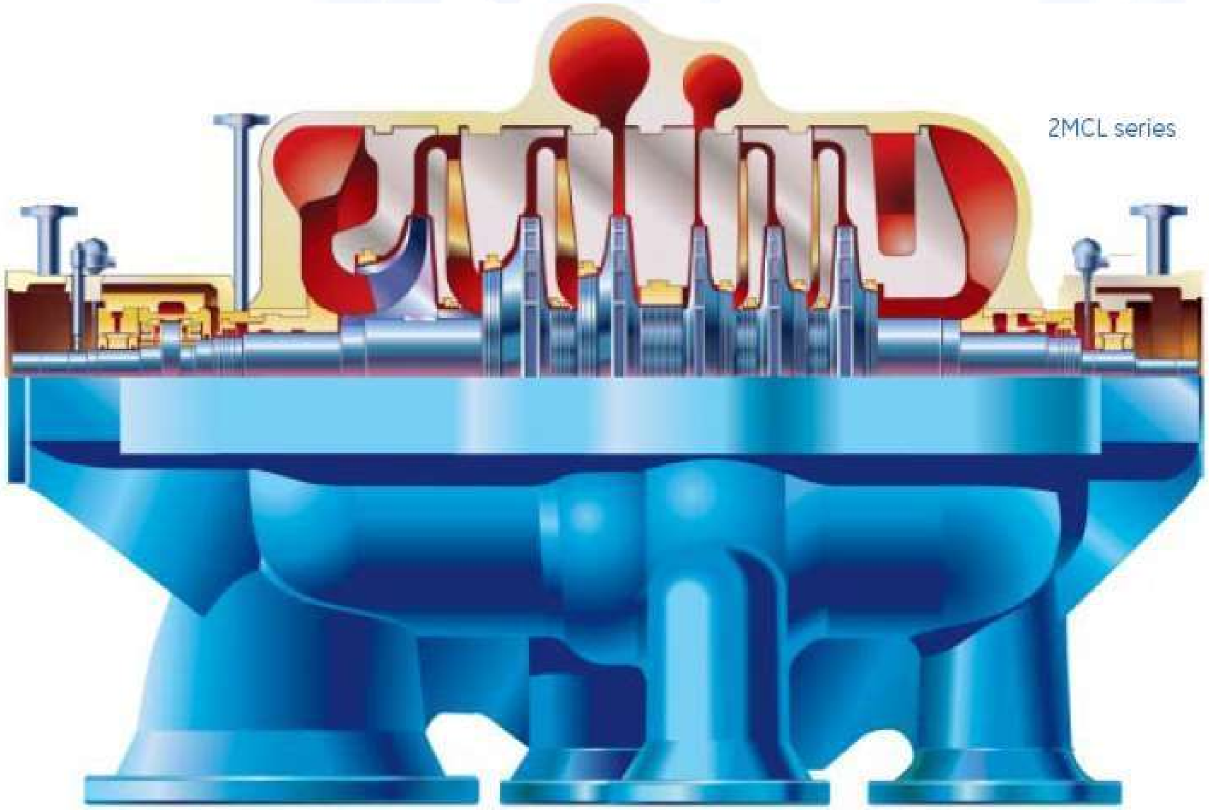
These multistage compressors have one compression stage only.





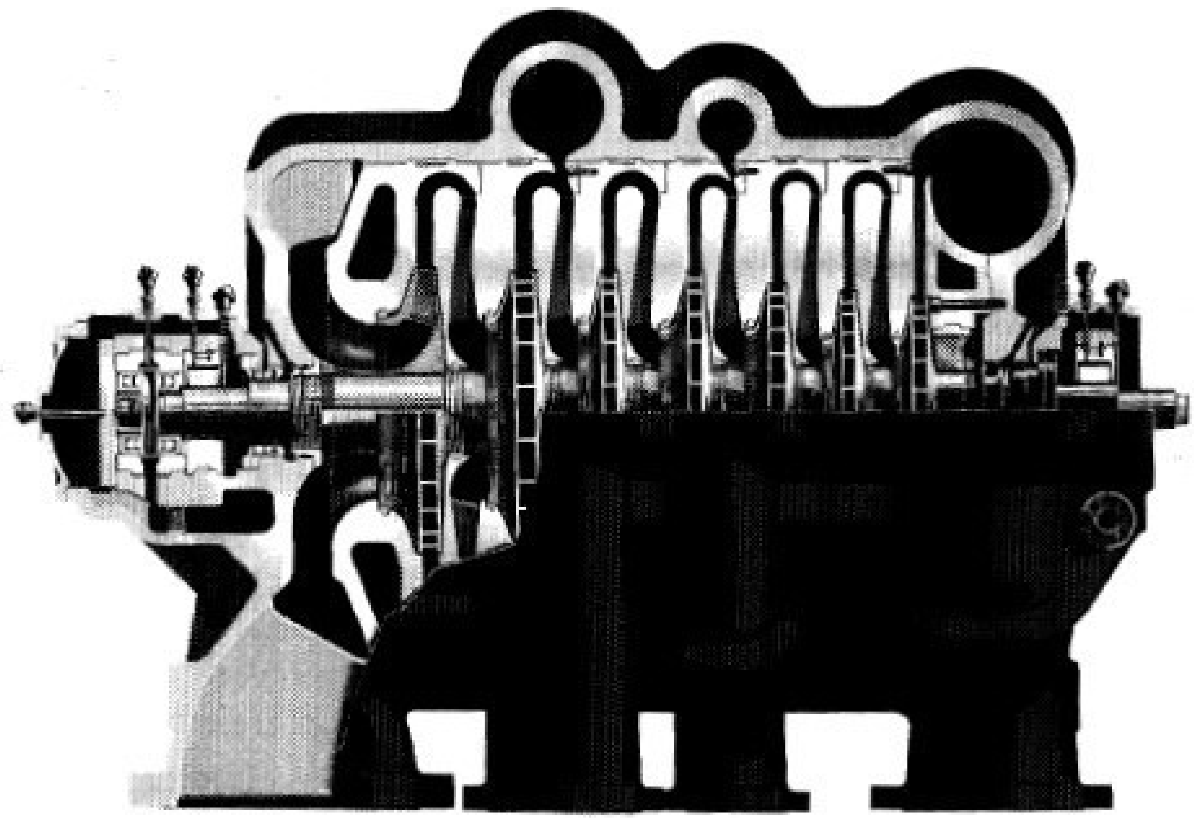
2MCL Compressors

These are multistage compressors which combine two compression stages in series in the same machine with interstage cooling.



3MCL Compressors

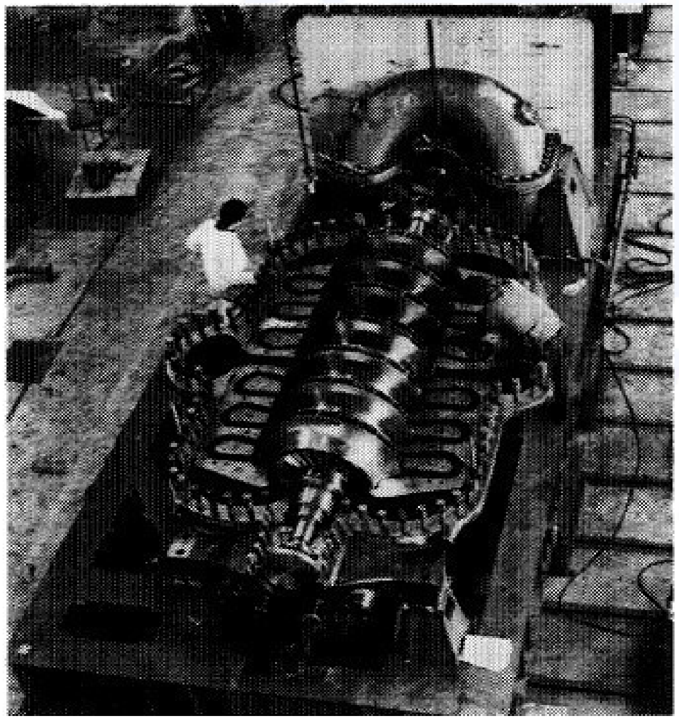
These are multistage compressors which generally incorporate more than two compression stages in a single casing . As a rule they are used in services where different gas flows have to be compressed tovarious pressure levels, i.e. by injecting and/or extracting gas during compression.



DMCL Compressor

Two compression stages are arranged in parallel in a single casing. The fact that both stages are identical and the delivery nozzle is positioned in the center of the casing makes this solution the most balanced possible.

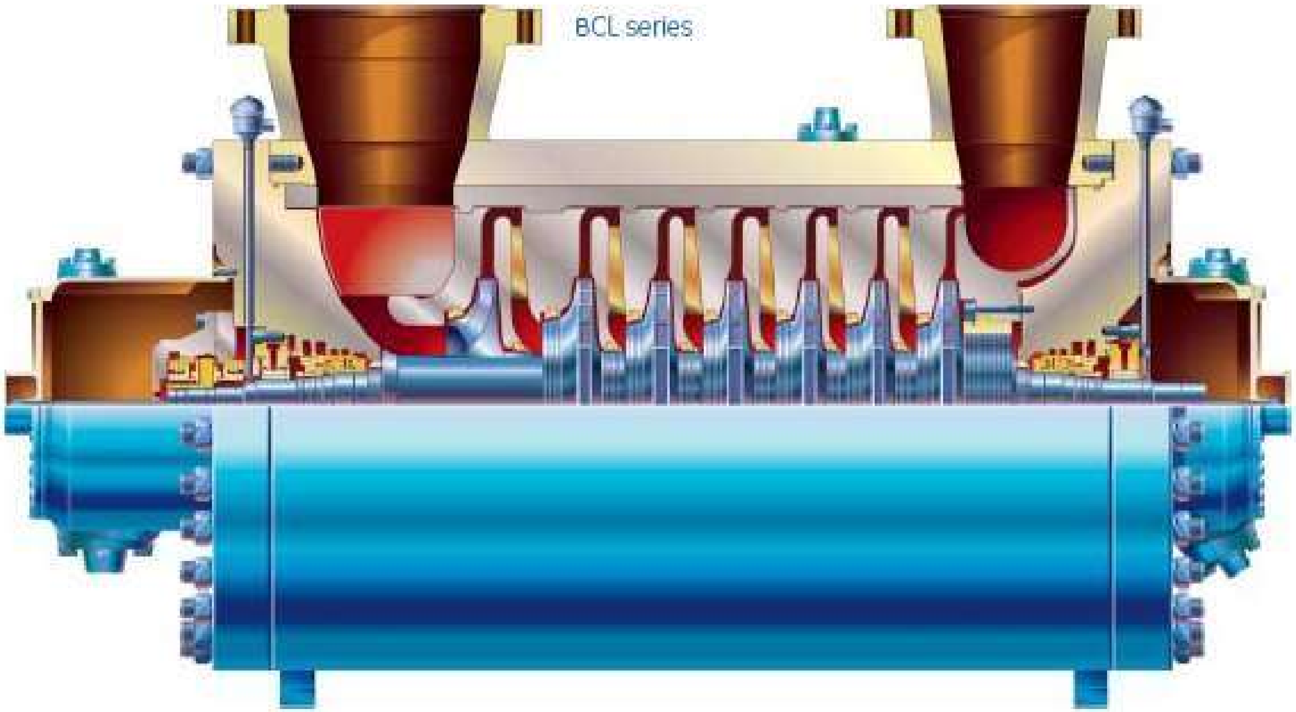
Moreover, a double flow is created by a common central impeller.



COMPRESSORS WITH VERTICALLY-SPLIT CASINGS

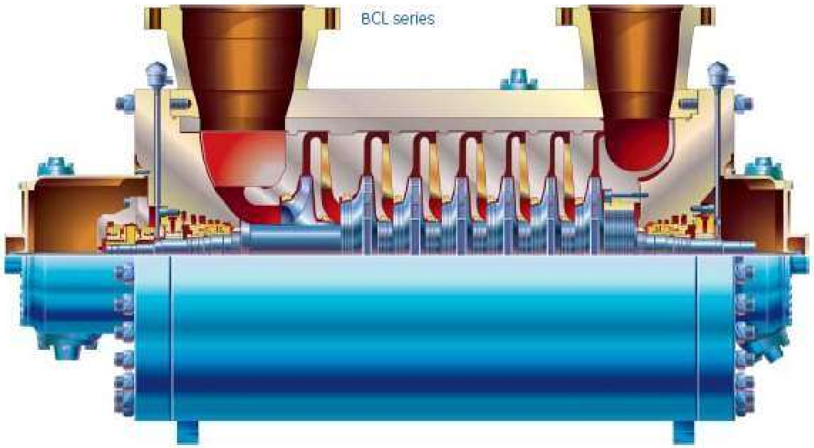
Vertically-split casings are formed by a cylinder closed by two end covers: hence the denomination "barrel", used to refer to compressors with these casings.

These machines, which are generally multistage , are used for high pressure services (up to 700 kg/cm2).



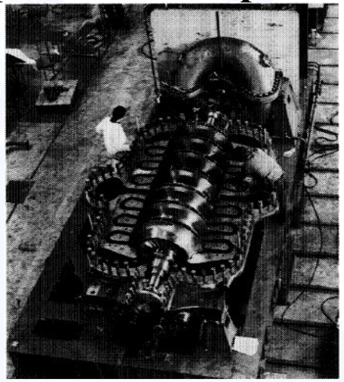
BCL Compressors

These are barrel type compressors which have a single compression stage.



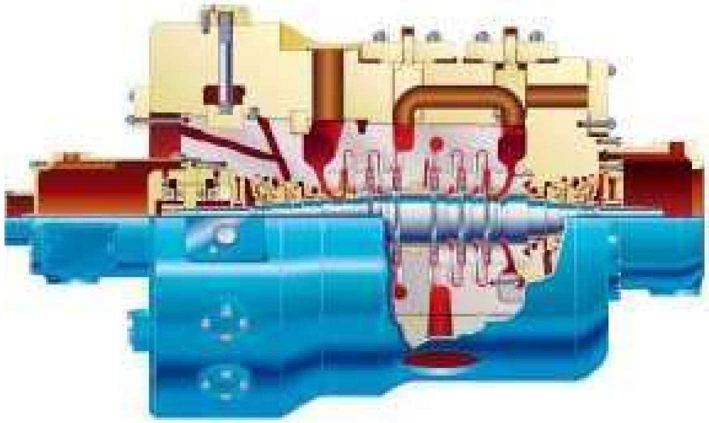
DBCL Compressors

Like the DMCL compressors (horizontally split casings) these compressors incorporate two compression stages in parallel in a single casing.



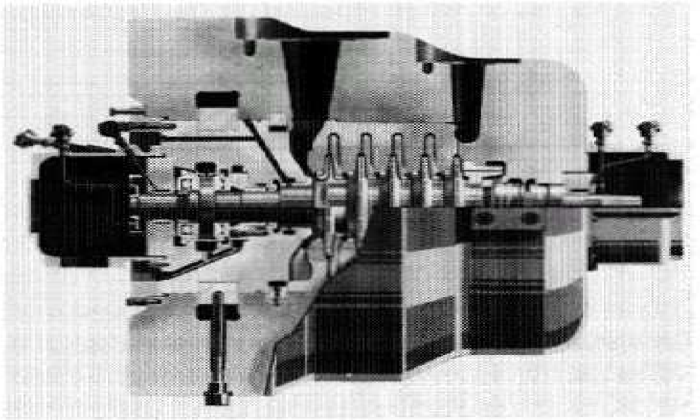
COMPRESSORS WITH BELL CASING fall into two group as follows:

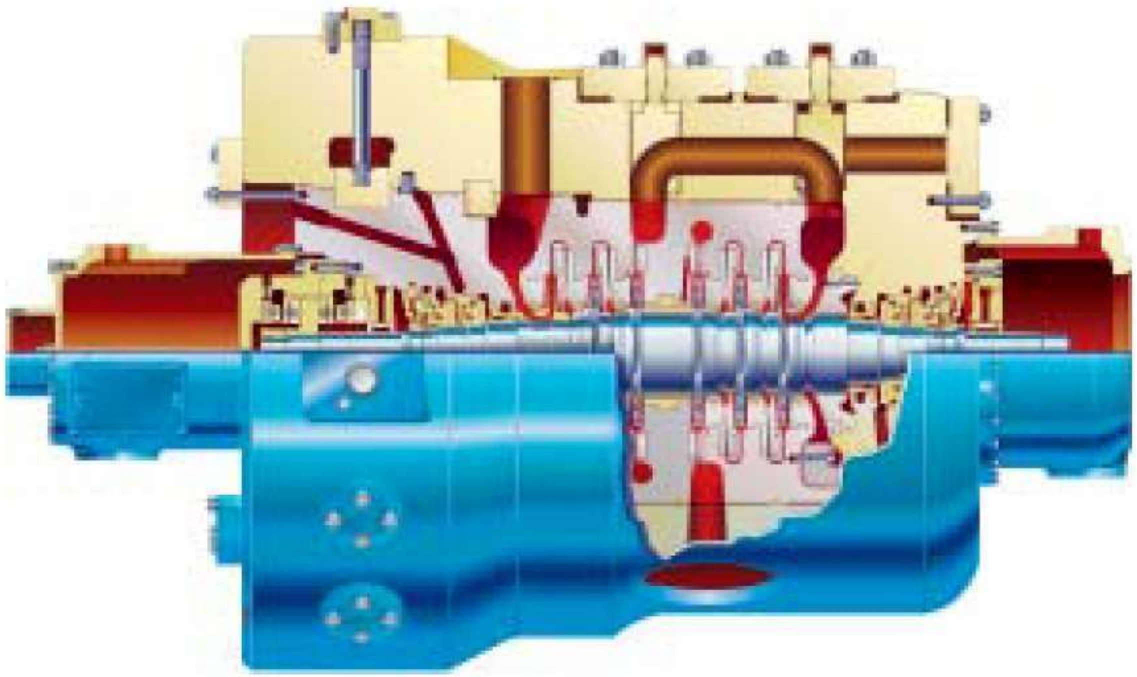
- **BCL Compressors with Bell Casings**
- **PCL Compressors**



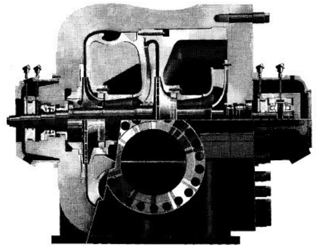
BCL Compressors with Bell Casings

Barrel compressors for high pressures have bell-shaped casings and are closed with shear rings instead of Bolts.

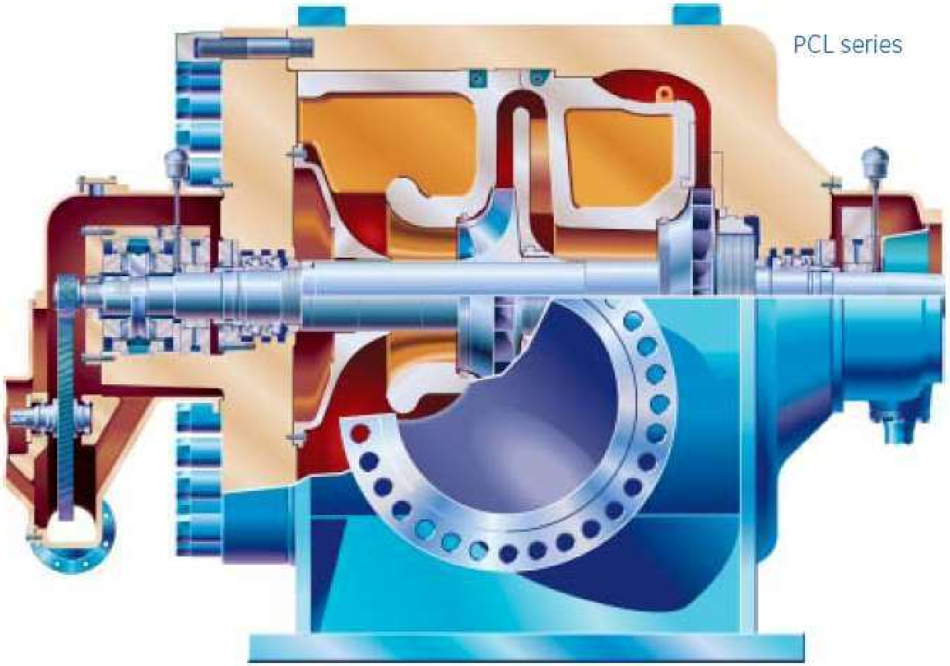


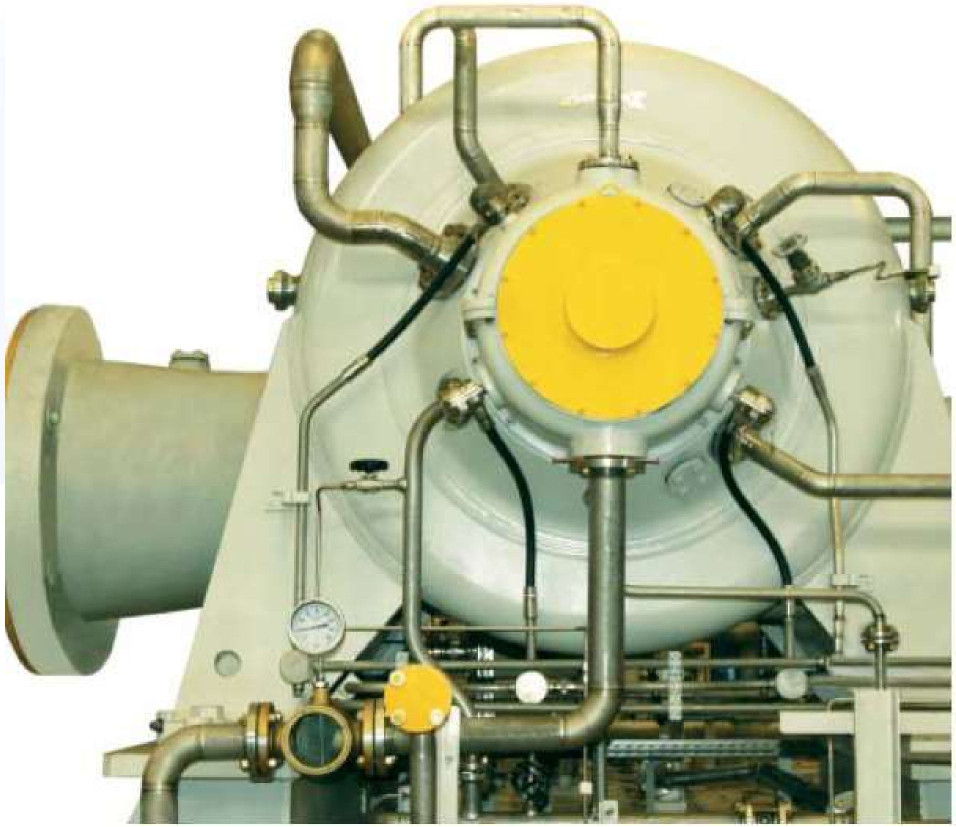


PCL Compressors

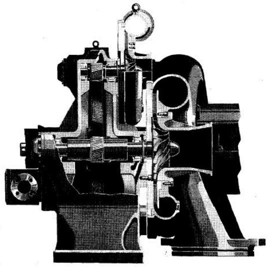


These have bell-shaped casings with a single vertical end cover instead of two as in BCL compressors.
They *are* generally used for natural gas transportaion . They normally have side suction and delivery nozzles positioned opposite each other to facilitate installation on gas pipelines.





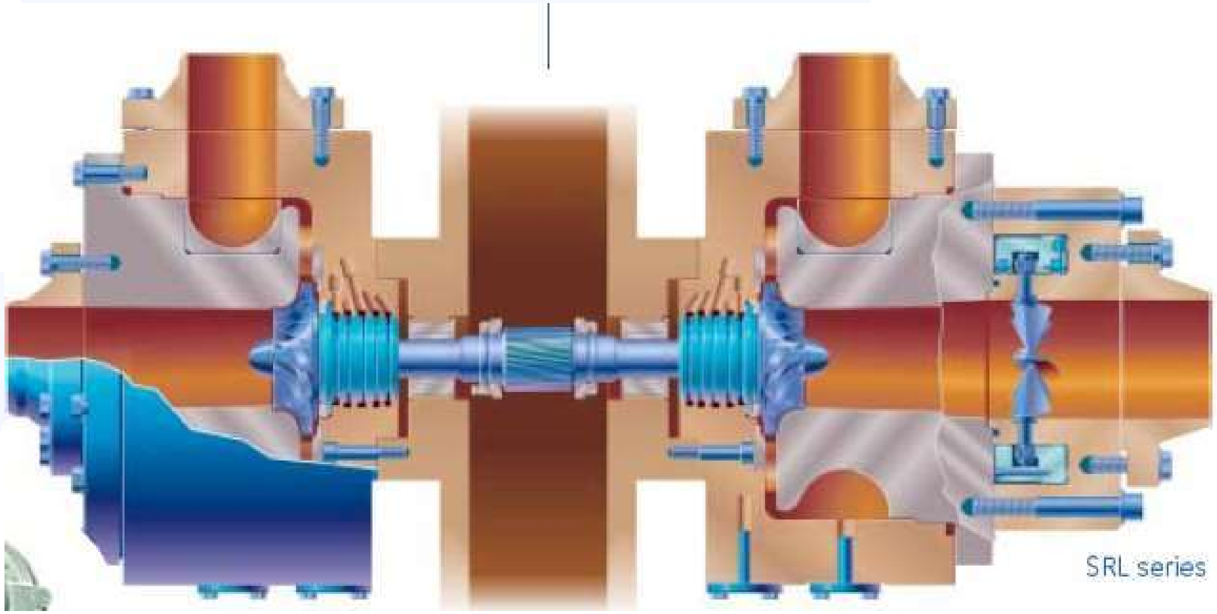
SR COMPRESSORS



These compressors are suitable for relatively low pressure services . They have the feature of having several shafts with overhung impellers.

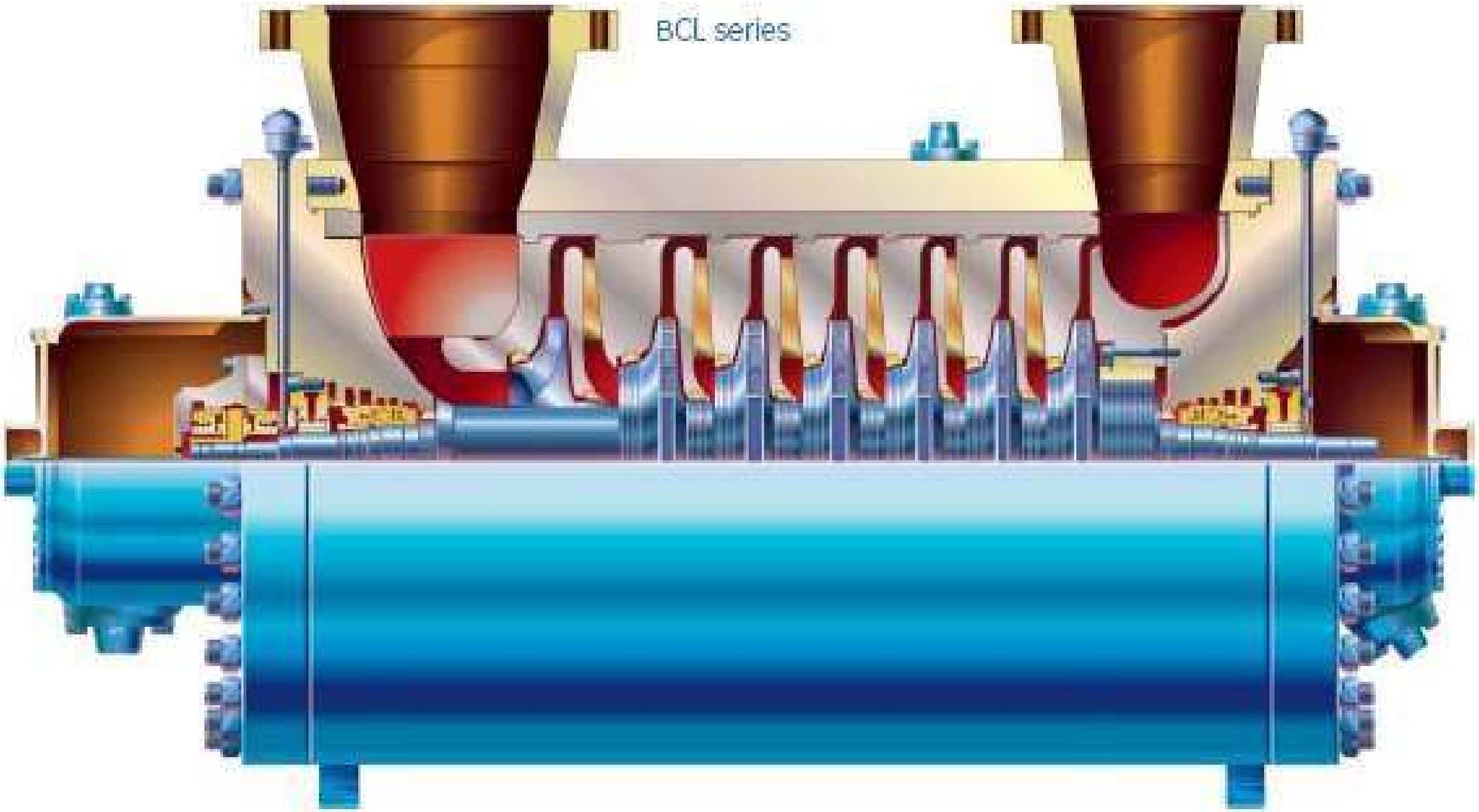
The impellers are normally open type, i.e., shroudless, to achieve high tip speeds with low stress levels and high pressure ratios per stage .

Each impeller inlet is coaxial whereas the outlet is tangential . These compressors are generally employed for air or steam compression, geothermal applications etc .



Injection Compressor

The BCL centrifugal compressors, used for gas injection, are fundamentally composed by an outer casing which contains a stator part, called diaphragm bundle.

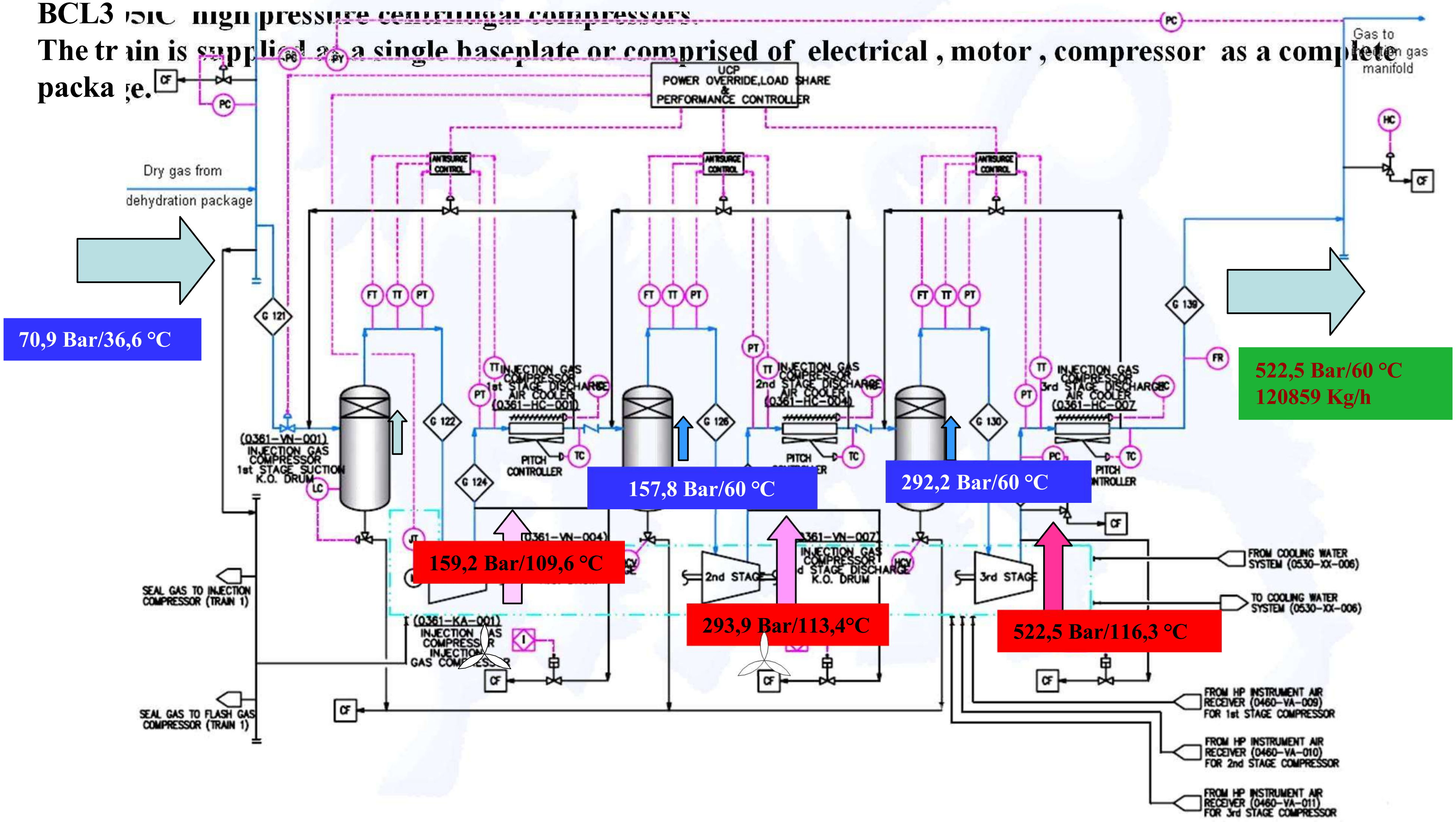


GAS INJECTION PLANT

The Motocompressors train is designed and supplied for use in a GAS INJECTION PLANT in Darquain Oil Field in Iran for NIOC.

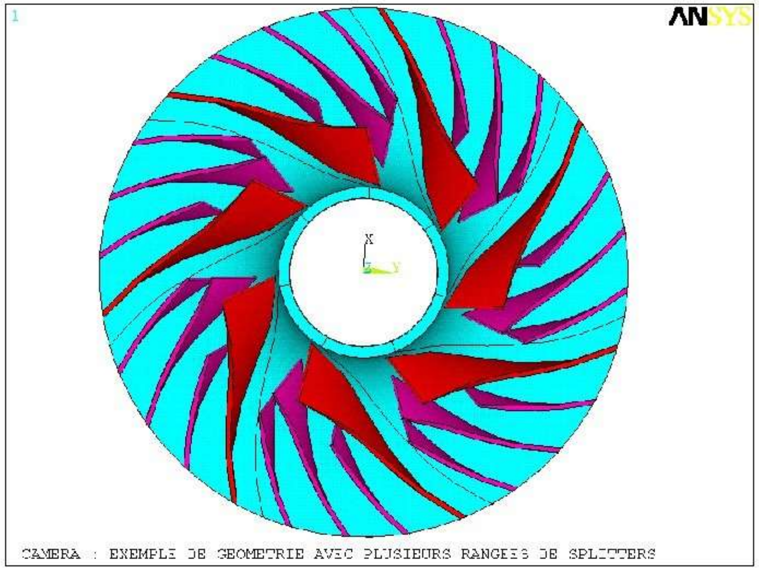
This train is composed of an Electric Motor driving with an increasing Gear Box and BCL304IA + BCL304IB + BCL304IC high pressure centrifugal compressors.

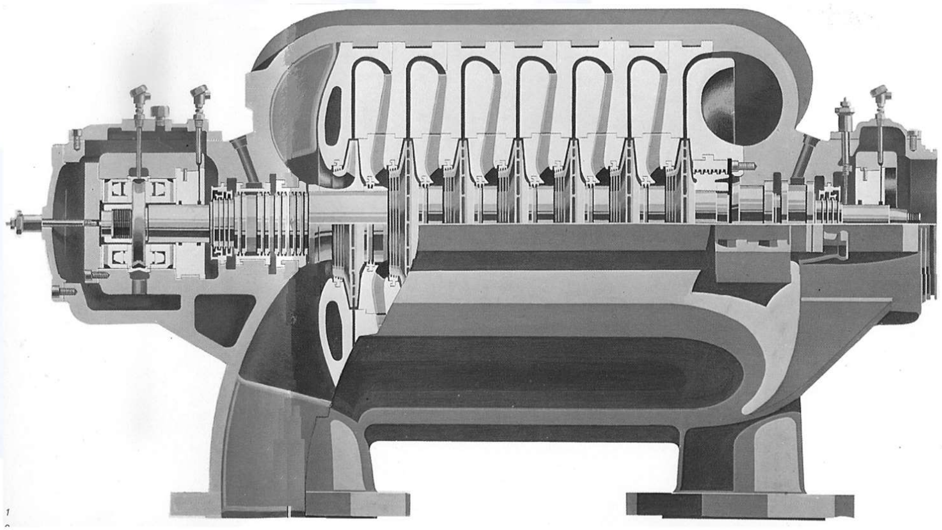
The train is supplied as a single baseplate or comprised of electrical , motor , compressor as a complete package.



Impeller

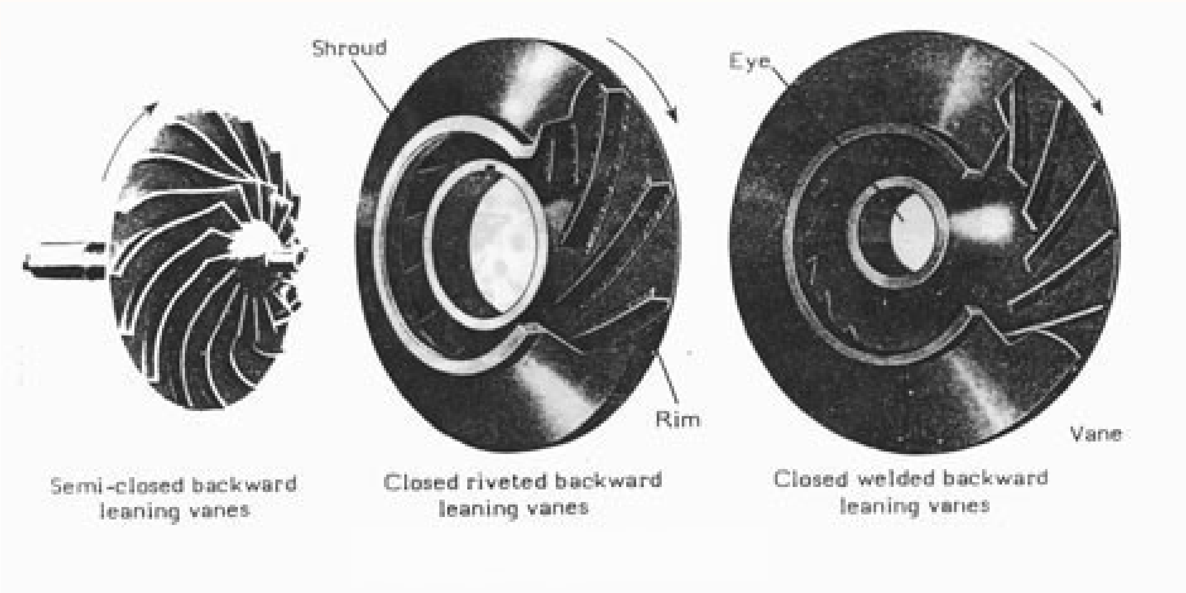
The impellers impart velocity energy to the gas being compressed. This velocity energy is then converted into increased pressure in the diffusing portions of the internal gas passages





Impeller

The impeller is the rotating element in a compressor that increases the gas pressure.
They come in many shapes and sizes. They are classed as open or closed, and/or by direction of vane curvature, and the method of construction (cast, milled, riveted, or welded).



Nuovo Pignone Impellers

Impellers are shrink - fitted on the shaft .Under the impellers splines are provided to transmit torque.
To avoid loosening of the mesh under high speed of rotation owing to the stresses caused by centrifugal forces , thus preventing the build up unbalance since the impeller would not be concentric to the shaft.

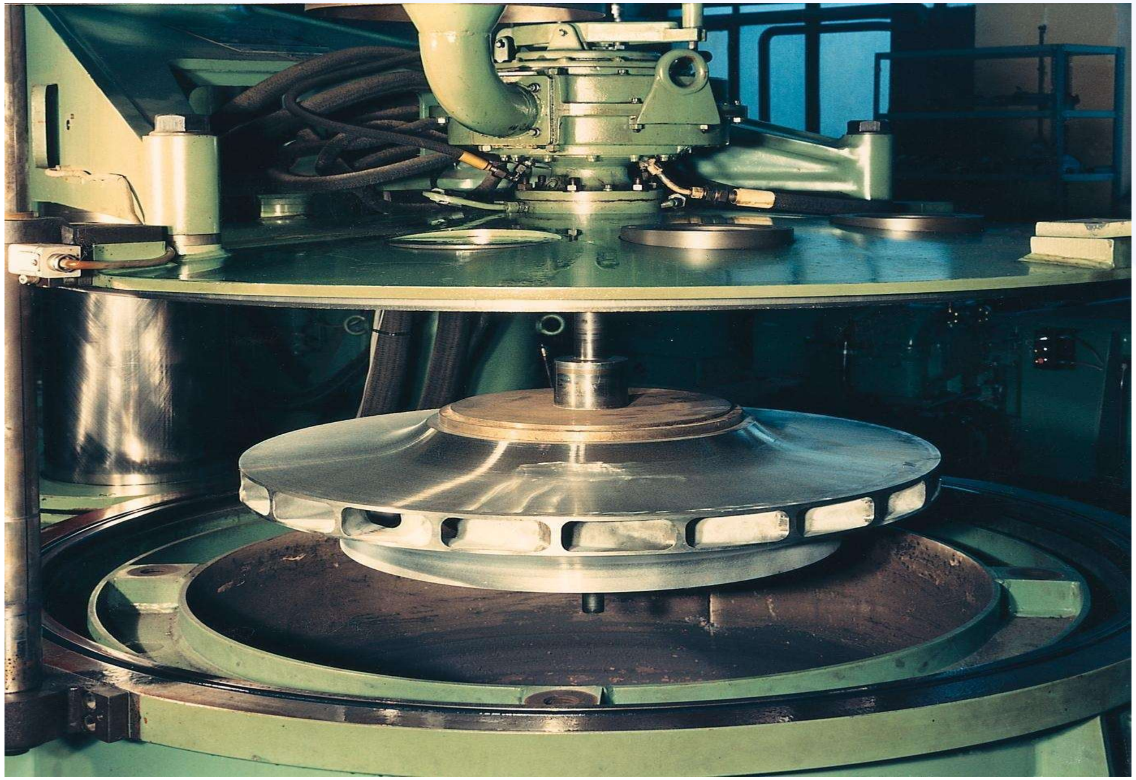
Nuovo Pignone Impellers

Impellers may be, structurally, either closed or open type. The closed impellers are made up of one hub, a certain number of blades and one shroud. Blading is generally slanted backwards, These parts are joined in different waysat present Nuovo Pignone apply only welding. Blades are generally milled on the hub. (or shroud), then the shroud. (or the hub) is internally welded.
The blades are milled onto the hub or shroud depending on the impeller shape and, hence, on the possibility for the electrode getting into the channel.

Nuovo Pignone Impellers

Due to the narrower width of the impeller, it is difficult to weld internally, external welding is carried out: on the shroud (or hub) near blading and according to its shape, grooves are carried out superficially. Hub and shroud are connected to each other by temporary butt-welding . By filling these grooves with weld material, the facing surfaces between blade and shroud are melted thus resulting in a weld.

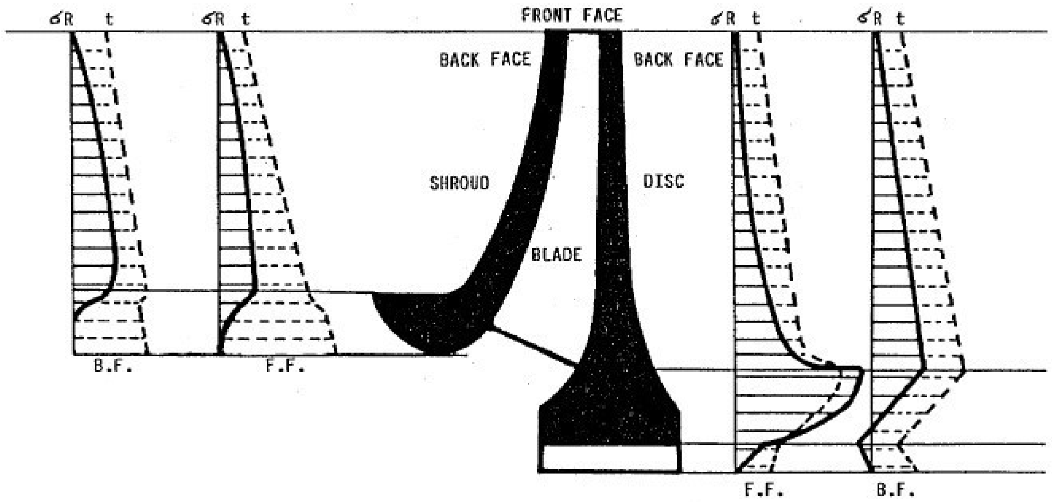
The impeller welding cycle is the following: welding carried out as described before, followed by stress relieving heat treatment, inspection of welded parts, hardening and tempering, removal of machining allowance. The open impellers are different from the closed impellers as lacking in the shroud. Usually this kind of impeller has tridimensional blades obtained by milling.

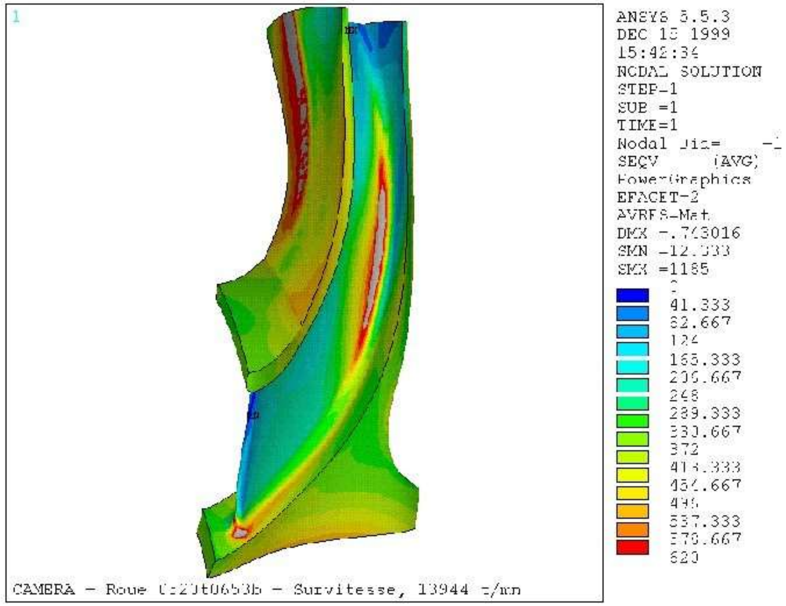


Nuovo Pignone Impellers

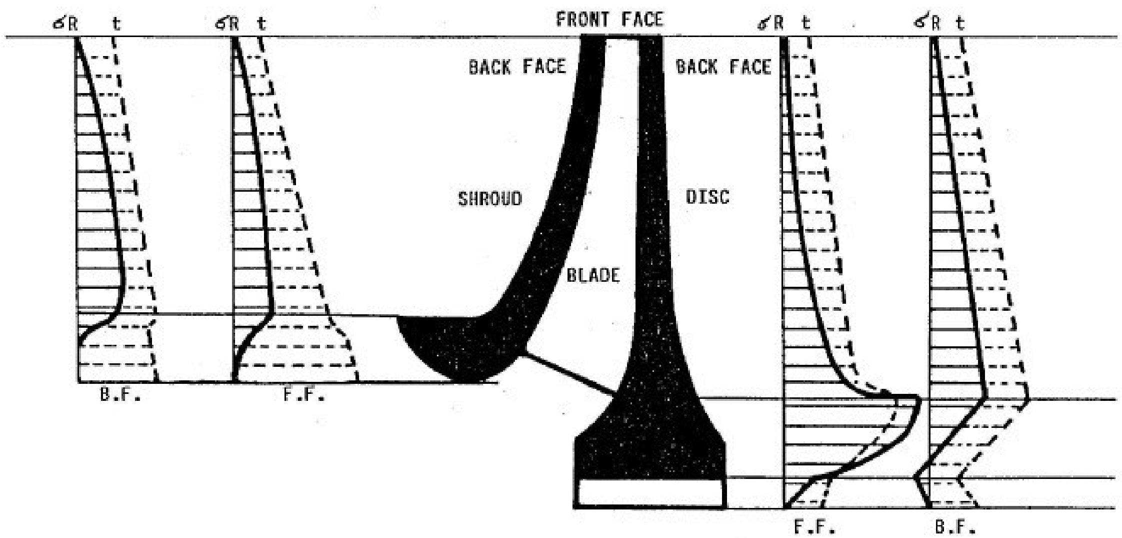
Blading can be radial or slanted backwards according to the characteristic and head we want to reach.
As to the mechanical design it has t o be taken into account that the impellers are the most stressed elements in a compressor, because the advantage of reducing the stage number leads to higher and higher tip speeds and, hence, stresses.

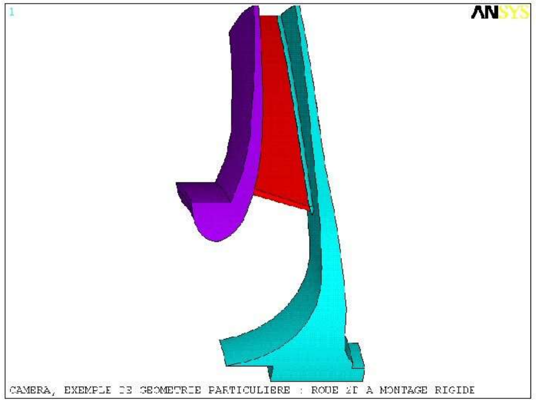
The stress trend in the various impeller parts varies , of course, according to the impeller type; diagrams in following pictures show a typical situation.

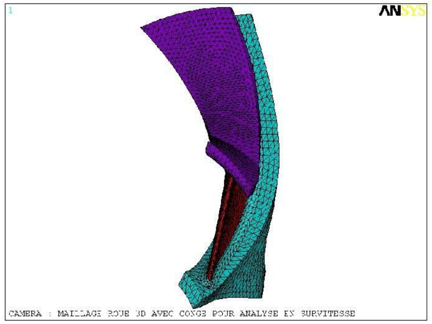




The stress condition showed there in concerns a reference tip speed of 300 m/s. The values corresponding to the various speeds are proportional to the speed ratio square.





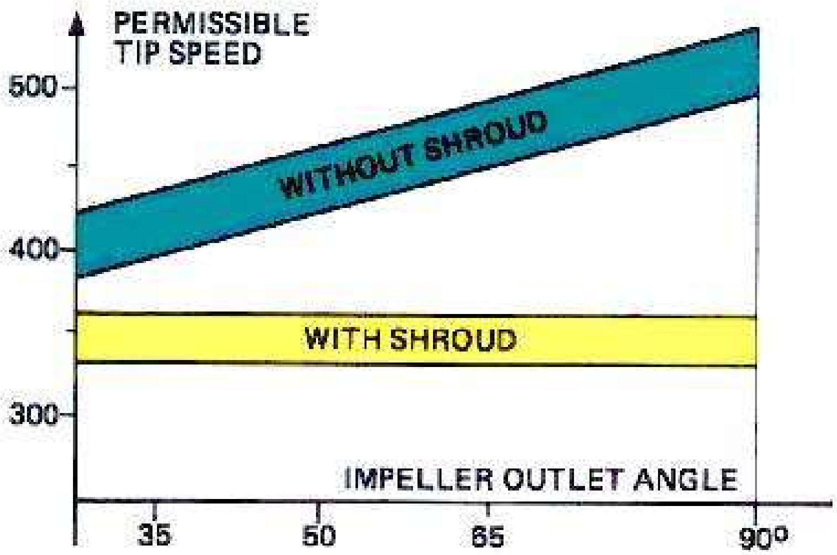


The severest condition occurs during the overspeed test (at 115% of the continuous max. speed), The diagram shows particularly stressed areas on the leading edge of blades. Stress concentrations must be avoided.

Impeller

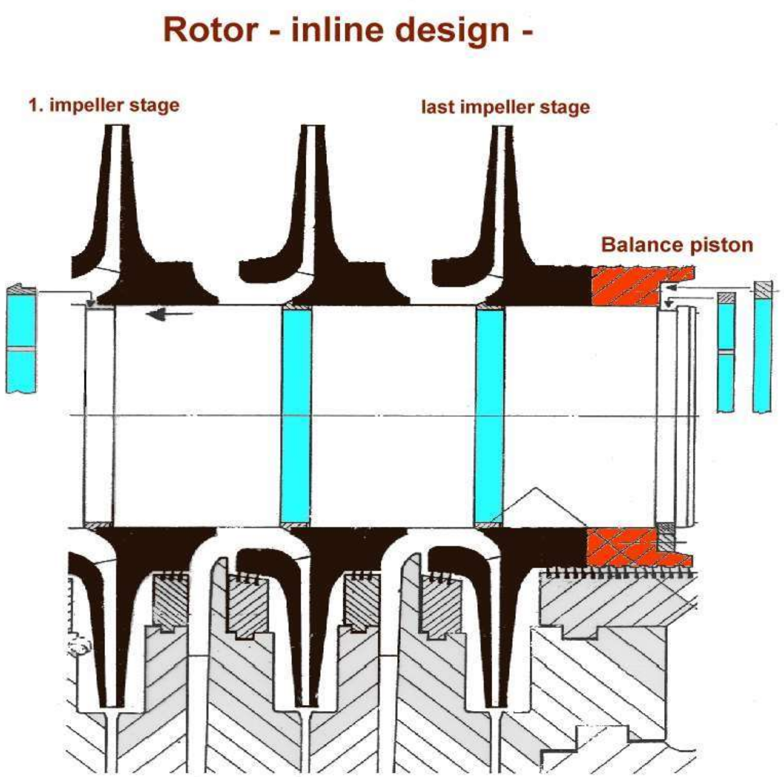
Vanes can curve frontward, be straight (called radial), or curve backward. Most compressors use backward leaning vanes.
The backward leaners are more efficient and more stable, but will produce slightly less pressure rise than forward leaners under the same operating conditions.
Impellers undergo rigid material tests and dynamic balancing (spin tests) during manufacture and after machining, speeds are usually 110-115% of maximum operating rpm.

Permissable Tip Speed:



Impeller . Shaft assembly

A good, homogeneous metal must be used that is capable of being machined to close tolerances. To reduce cost and protect the shaft core, shafts are often made of mild steel and then plated with chrome, stainless steel, or other hardened metal. Parts of the shaft exposed to wear or corrosion (such as the area around the seals) are often protected with a removable sleeve which is made of special alloys



Impeller . Shaft assembly

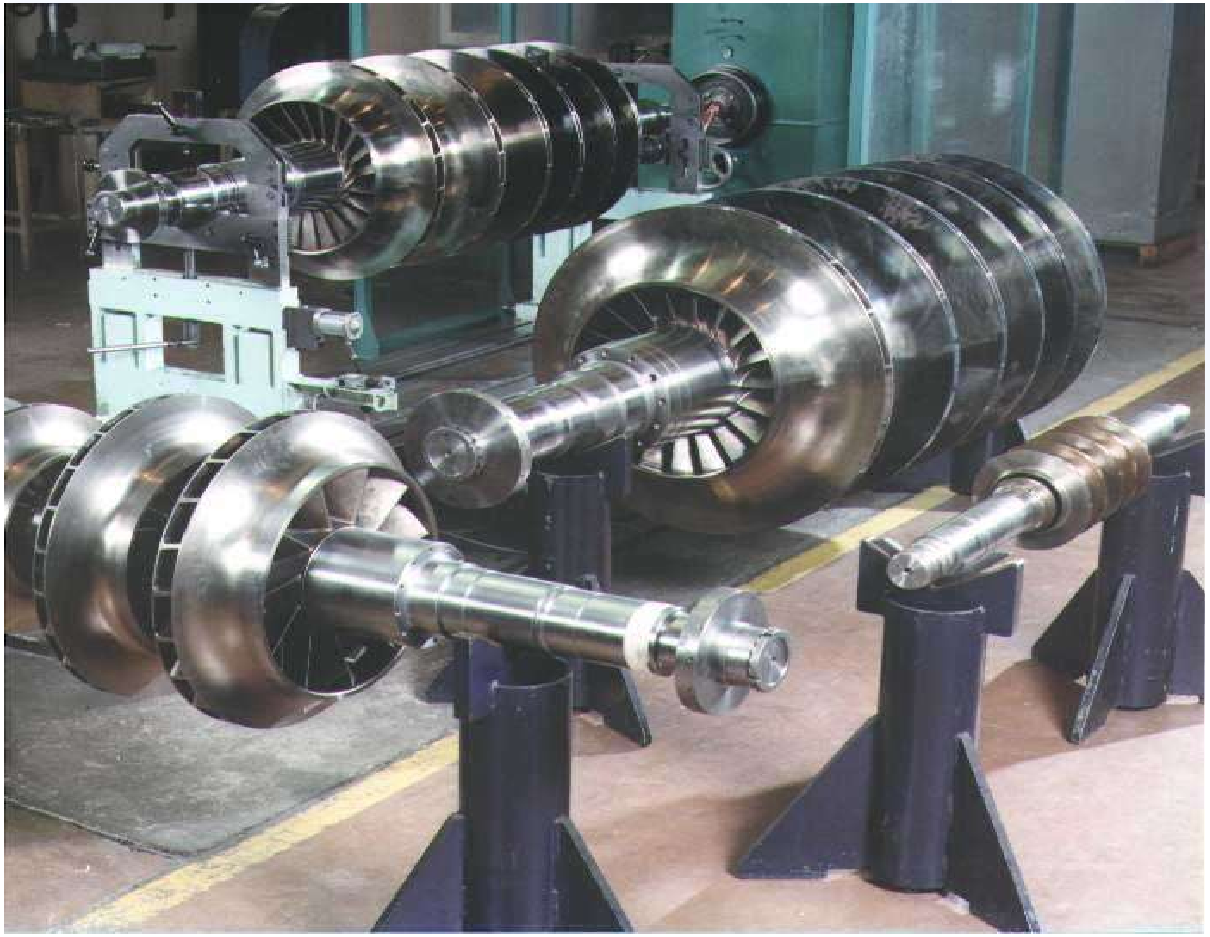
Shafts are machined for a) a shrink-fitted different sized impellers at different locations b)balancing drum on one end c) journal and/or thrust bearing surfaces d) shaft-end coupling arrangements e) oil slinger rings sealing surfaces.

Such machining is normally done to extremely close tolerances, 10 to 120 microns [0.0005 to 0.005 inches].

Impellers are positioned on the shaft with sleeves that are keyed or shrink-fitted to the shaft.
The sleeves also protect the shaft from corrosion, erosion, and mechanical wear.
As each impeller, sleeve, etc. is fitted to the shaft, the rotor assembly is statically and dynamically balanced to exacting tolerances;then, a final balance is made when the assembly is complete. AboveFigure shows a rotor Undergoing dynamic balancing.
Careful balancing is necessary. At high speeds, vibration of the rotor inside the casing can cause extensive damage.

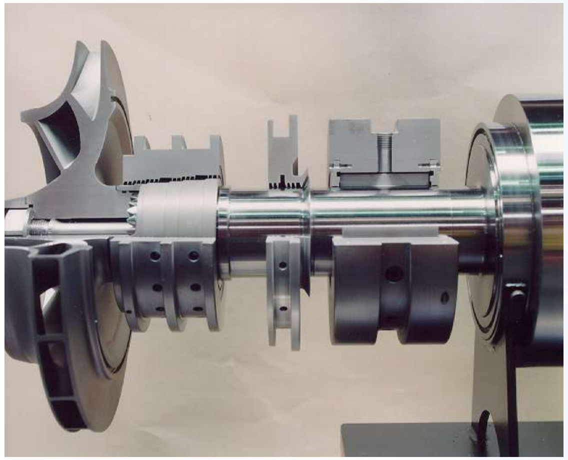
Impeller . Shaft assembly

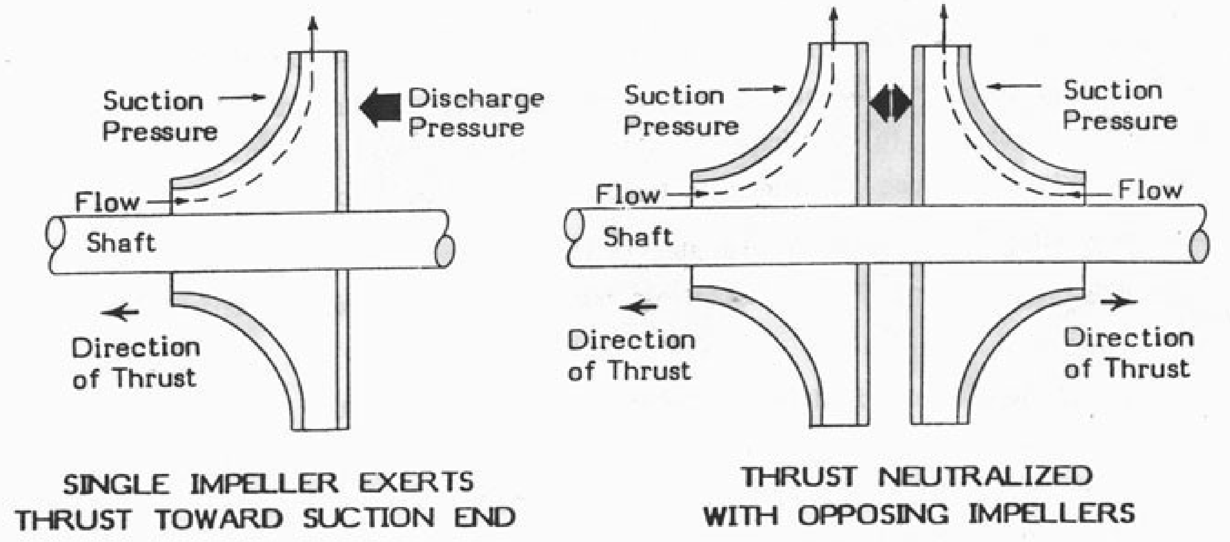
Although the rotor is carefully balanced, it will still vibrate at two or three different speeds. These vibration points, called critical speeds, can be predicted. They are checked by actual test, and normal operating speed is set to avoid these points.



Balance Drum

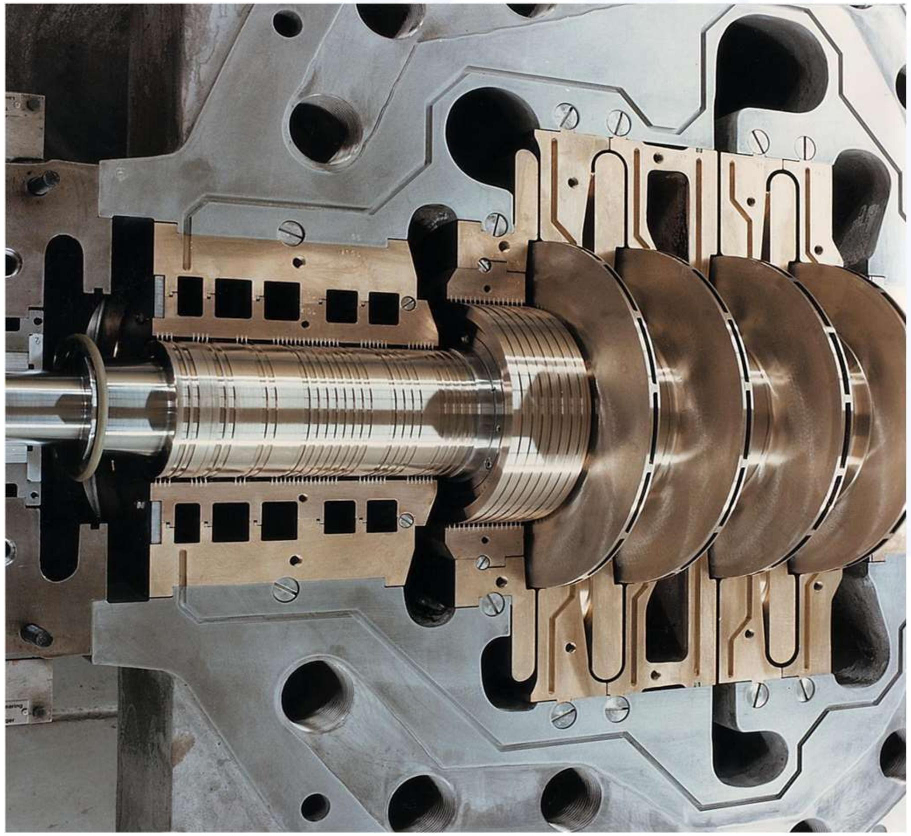
A multi-stage rotor might have extreme forces pushing it toward the suction end.
There are several ways to minimize this thrust force. Some of the impellers may be reversed on the shaft, so that the resultant thrust of opposing impellers cancel out. Another method is to machine spiral ribs on the back of the impellers. These ribs cause a "pumping" action, which reduces the amount of thrust pressure.

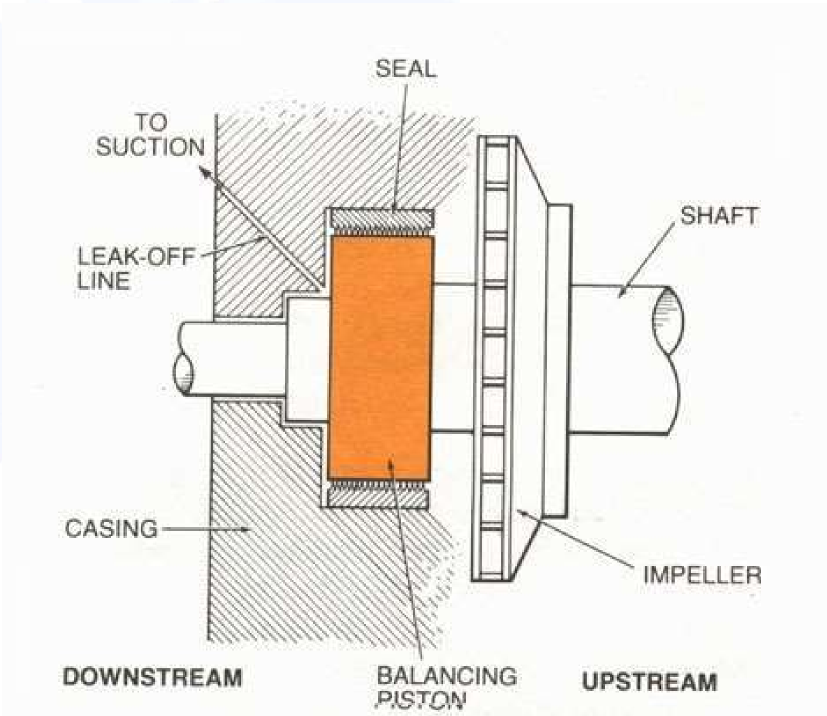




Balance Drum

The most common method of balancing opposing forces is with a balancing drum or piston, shown in below .
A solid metal cylinder is fitted to, and made a part of, the shaft just behind the last impeller.
Full discharge pressure pushes against one side, while compressor suction pressure is piped to the other side.
Proper sizing of the balance drum allows control of the direction of resultant thrust.
Zero thrust is not necessarily desirable.

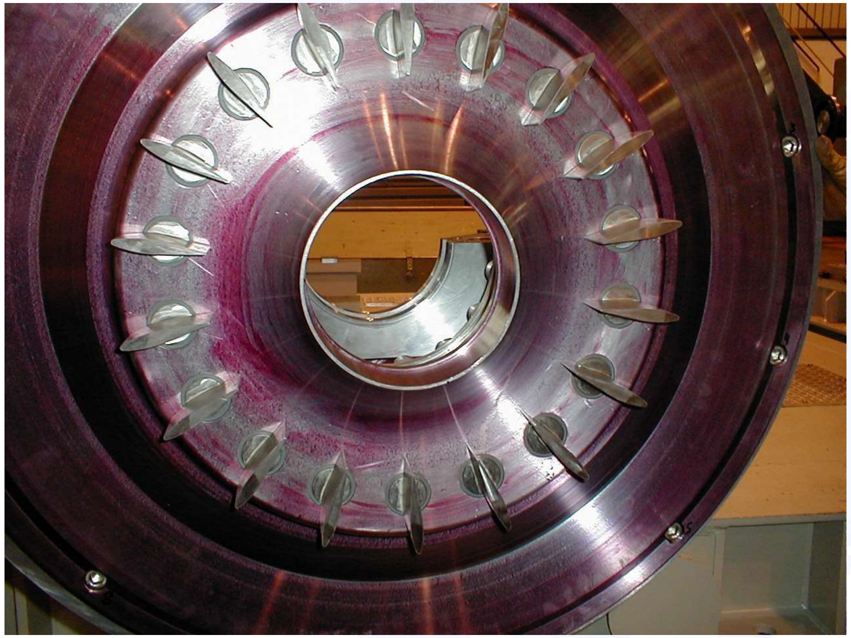


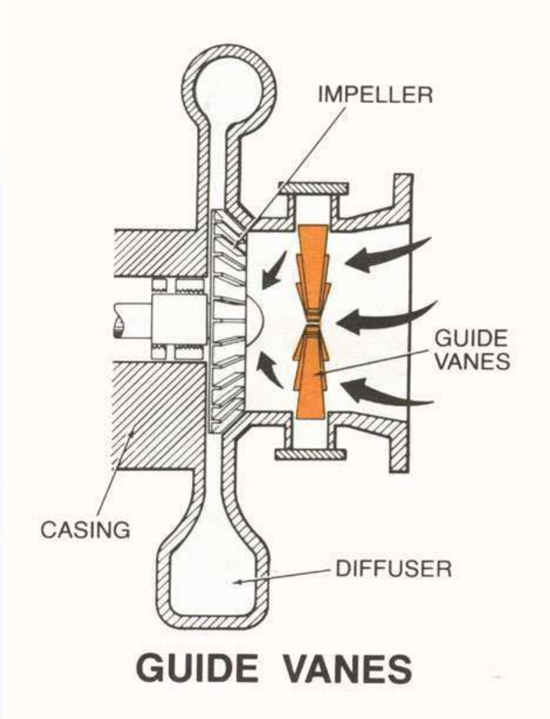


Guide Vanes

Compressor performance is affected by two factors. These are:

- The direction that the process gas enters the impeller eye.
- The velocity of process gas approach to the impeller eye.

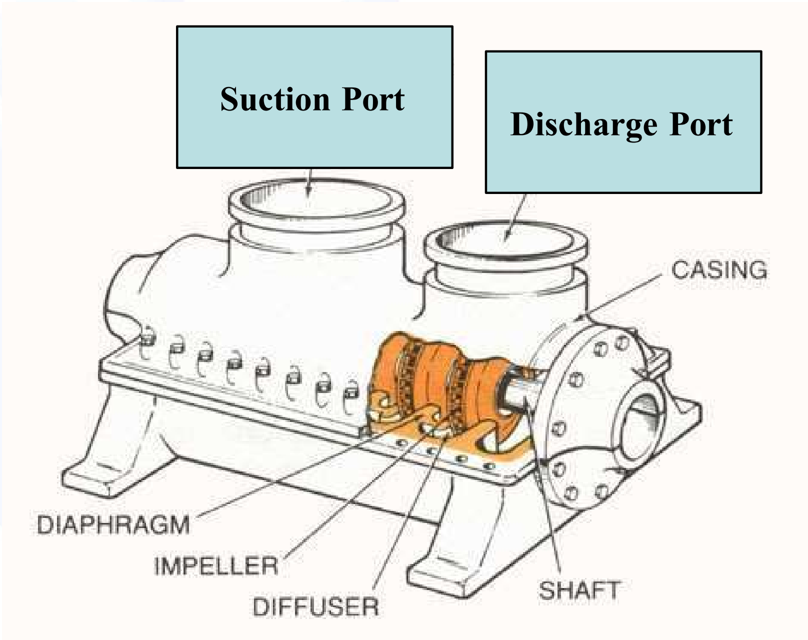




If the process gas can be made to enter the impeller in the same direction as the impeller rotation then the efficiency of the compressor will be increased. However if the process gas enters in the opposite direction to the impeller rotation, the capacity and gas pressure rise of the unit can be increased slightly.

Diffuser

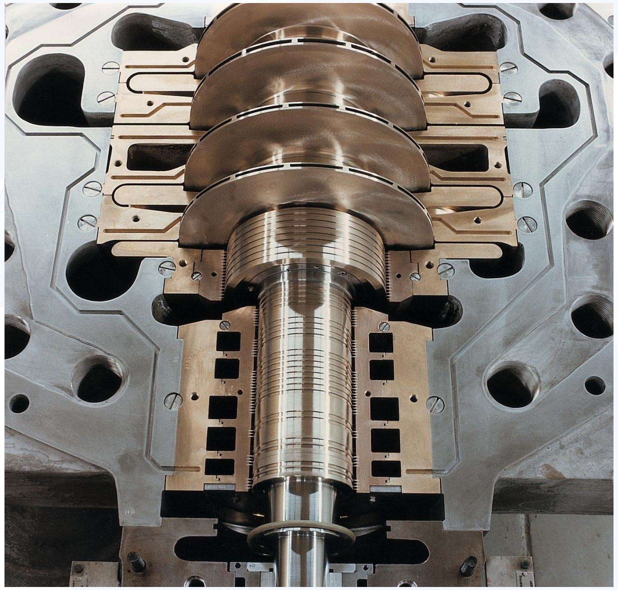
The radial diffuser of the centrifugal compressor is the stationary component, downstream of the impeller. , whose main function is to reduce the high velocity of the flow leaving the impeller, with the minimum amount of losses, and to convert as large a fraction as possible of the dynamic pressure into additional static pressure.

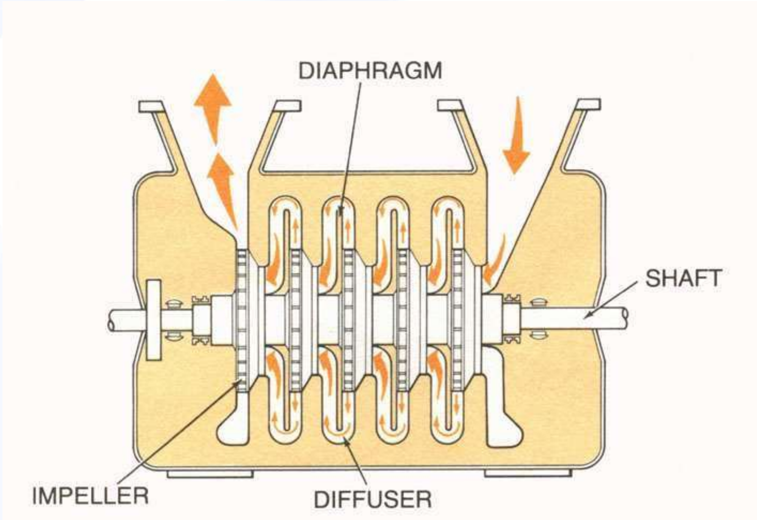


The diffuser may be vaneless or vaned. The vaneless diffuser consists of a radial channel limited by two circumferential walls. The vaned diffuser consists of diffusing channels between vanes, where the diffusion process is accomplished in a much shorter flow path with much higher efficiency than in the vaneless.

Diaphragms

The diaphragm is a device which separates the stages in a compressor. It is important to note that vertically-split and horizontally-split casing possess horizontally-split diaphragms to permit easier maintenance.





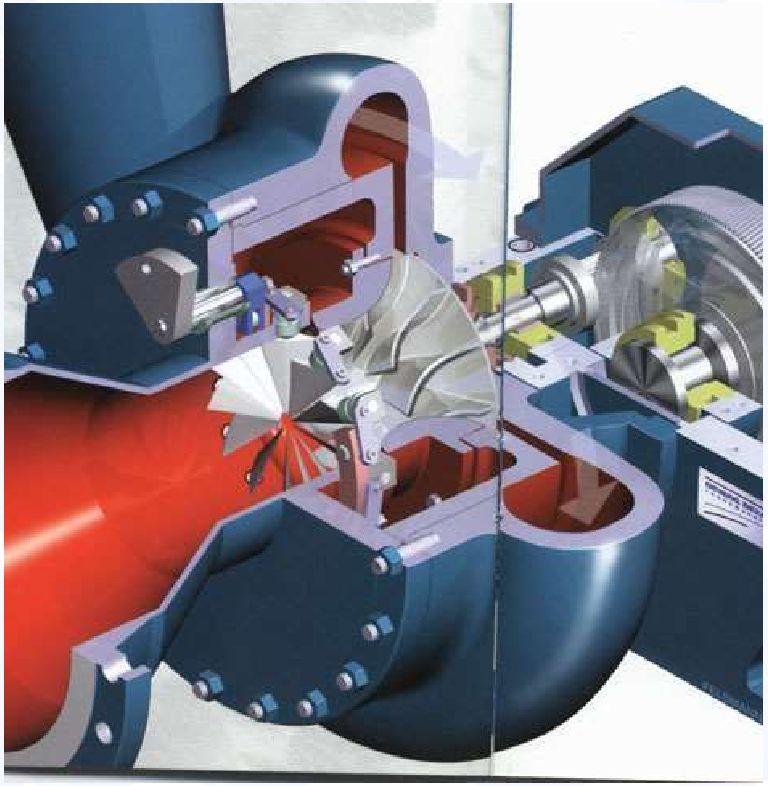
The process of compression generates heat and the result of this is that in some large, horizontally-spilt compressors the heat can cause unwanted expansion of the diaphragm. This effect can be prevented by supplying cooling water to the diaphragms.

The diaphragms may be fabricated from a variety of metals including cast iron, cast bronze, cast steel and alloys.

Diaphragms made from cast iron cannot be subjected to high differential pressure without failure occurring. In addition, thermal shock, in compressors in refrigeration processes, must similarly be avoided where there are cast iron diaphragms. High differential pressures usually occur during shutdowns of the compressor

Casing

Just as a pipe encases gas during transportation, some type of enclosure must house the parts which actually cause a rise in pressure. A simple casing encloses a single impeller-generally found in low pressure applications

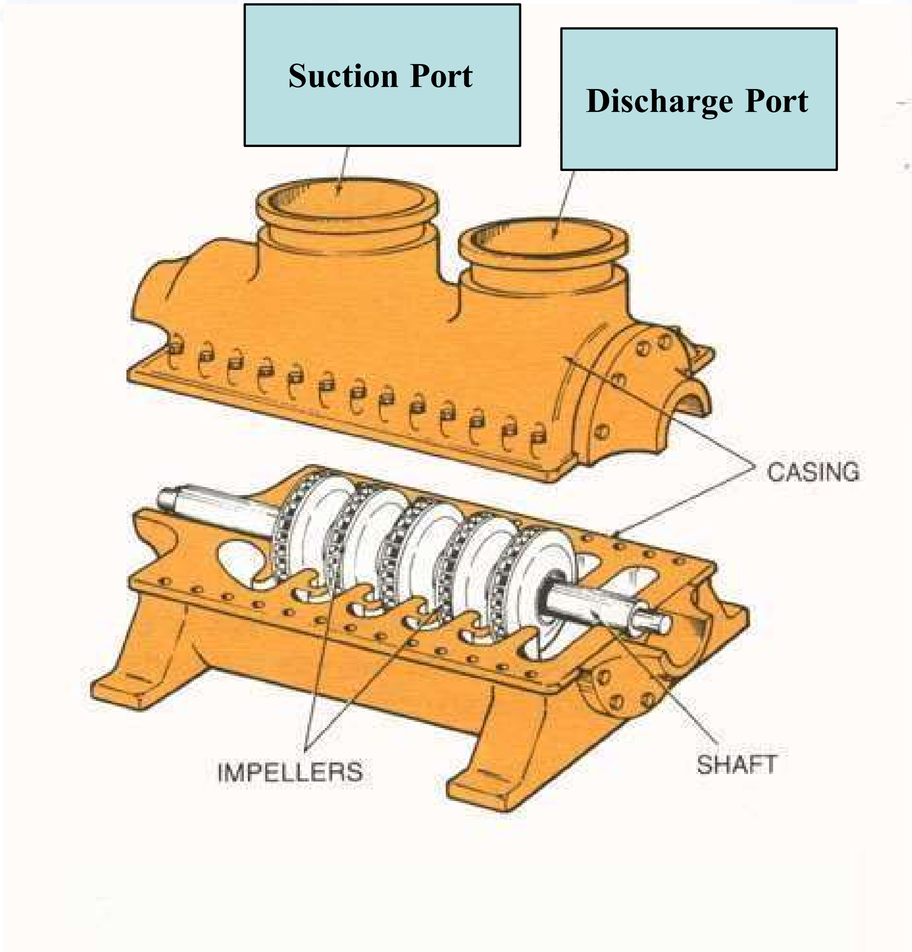


This type of casing is easy for repair and maintenance entry. Usually a center cover can be unbolted to expose the impeller and single bearing.

◌As we know, for medium pressure ranges, 1.70-50 barg [20-700 psig], most manufactures use a *horizontally- split* casing arrangement

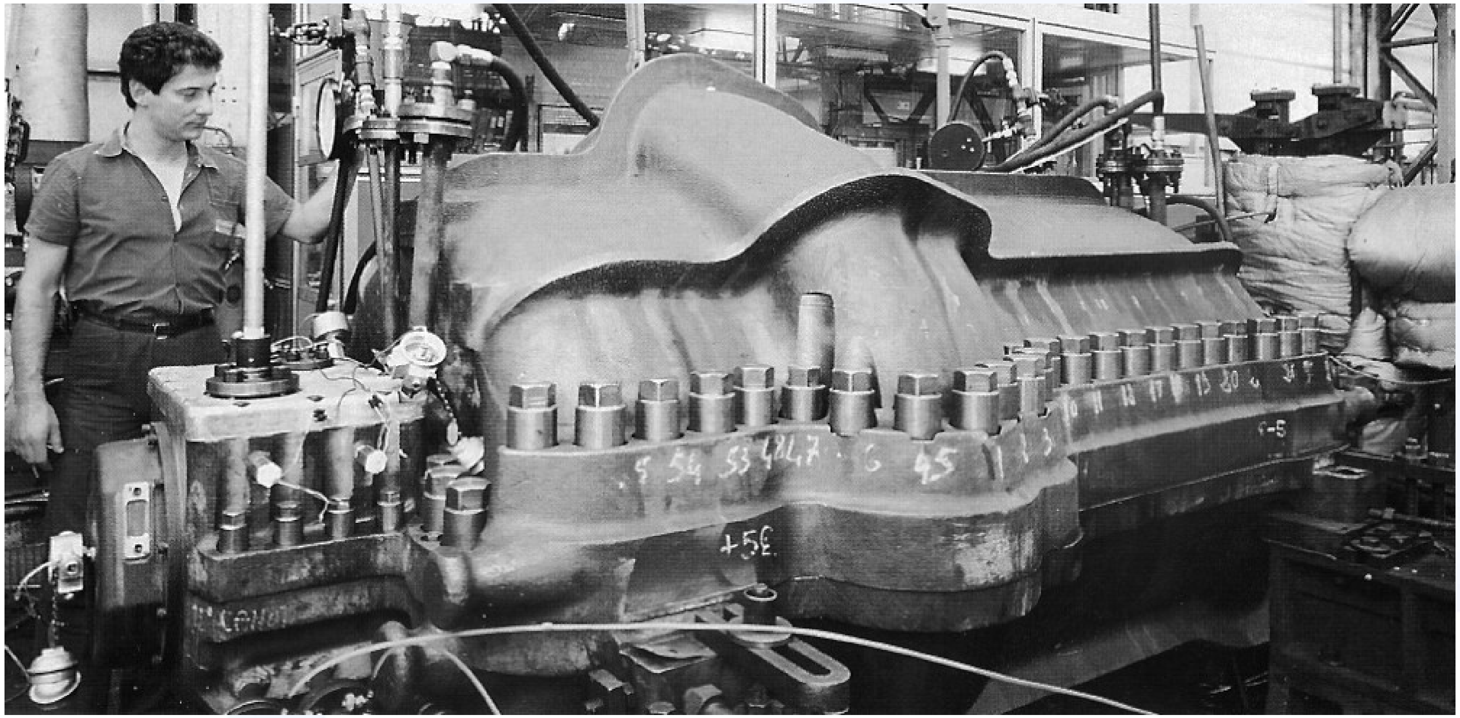
Horizontally split casing

In this type of casing, the top half can be removed easily to get to the working parts. The casing is built to split apart at the horizontal center line, the top and bottom halves being held together by bolts and positioned by dowel pins. By lifting the upper half casing, all compressor internals, such as the rotor shaft with its impellers, labyrinths, seals bearings, and diaphragms, are exposed for inspection and repair.



Horizontally split casing

These casings can be manufactured in several ways. Intake, discharge, and / or sideload connections may be placed pointing up, sideways, or down. Sideload nozzles allow intake or removal of gas at pressures between the inlet and the discharge, and are used for fuel gas takeoff, pickup of miscellaneous gasses, etc.
Several casings may be driven by one driver, the shaft being extended through both ends of the casing where necessary.

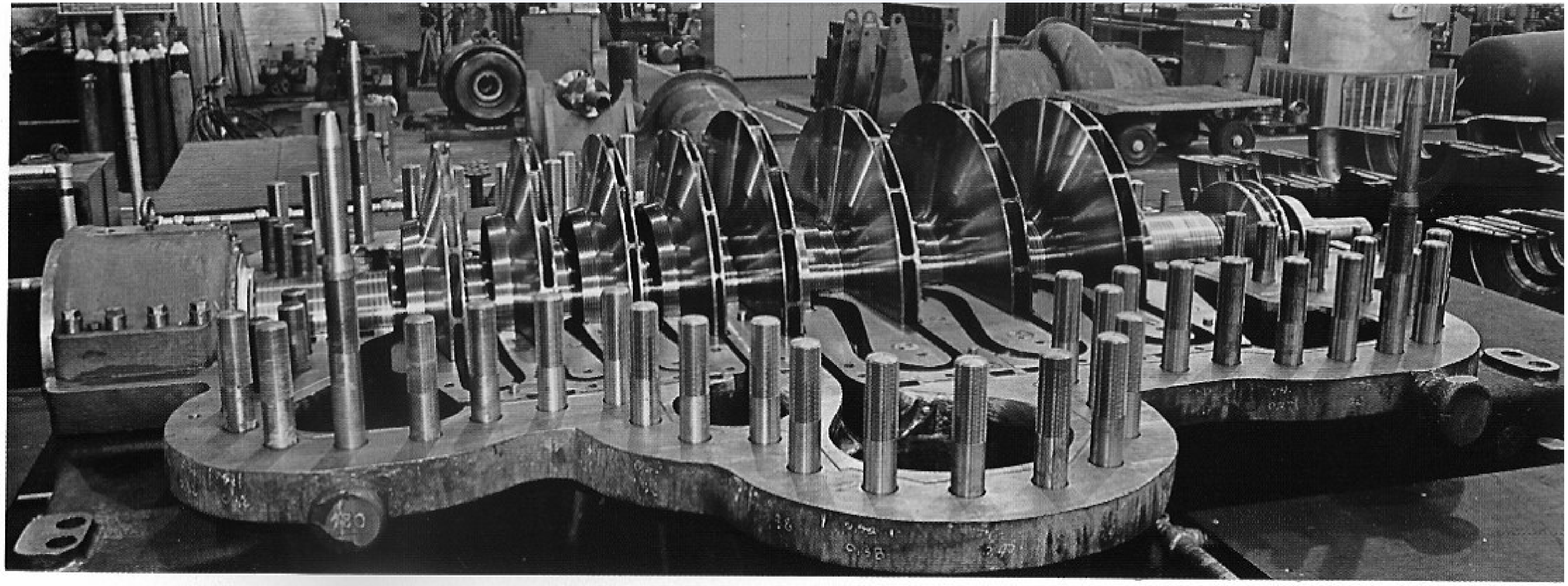


Horizontally split casing

Materials used for horizontally-split casings are determined by stress, temperature, and corrosion. For normal temperature ranges, -29º to 204ºC [-20º to 400ºF], gray cast iron, cast ductile iron, or cast steel of varying grades are used.

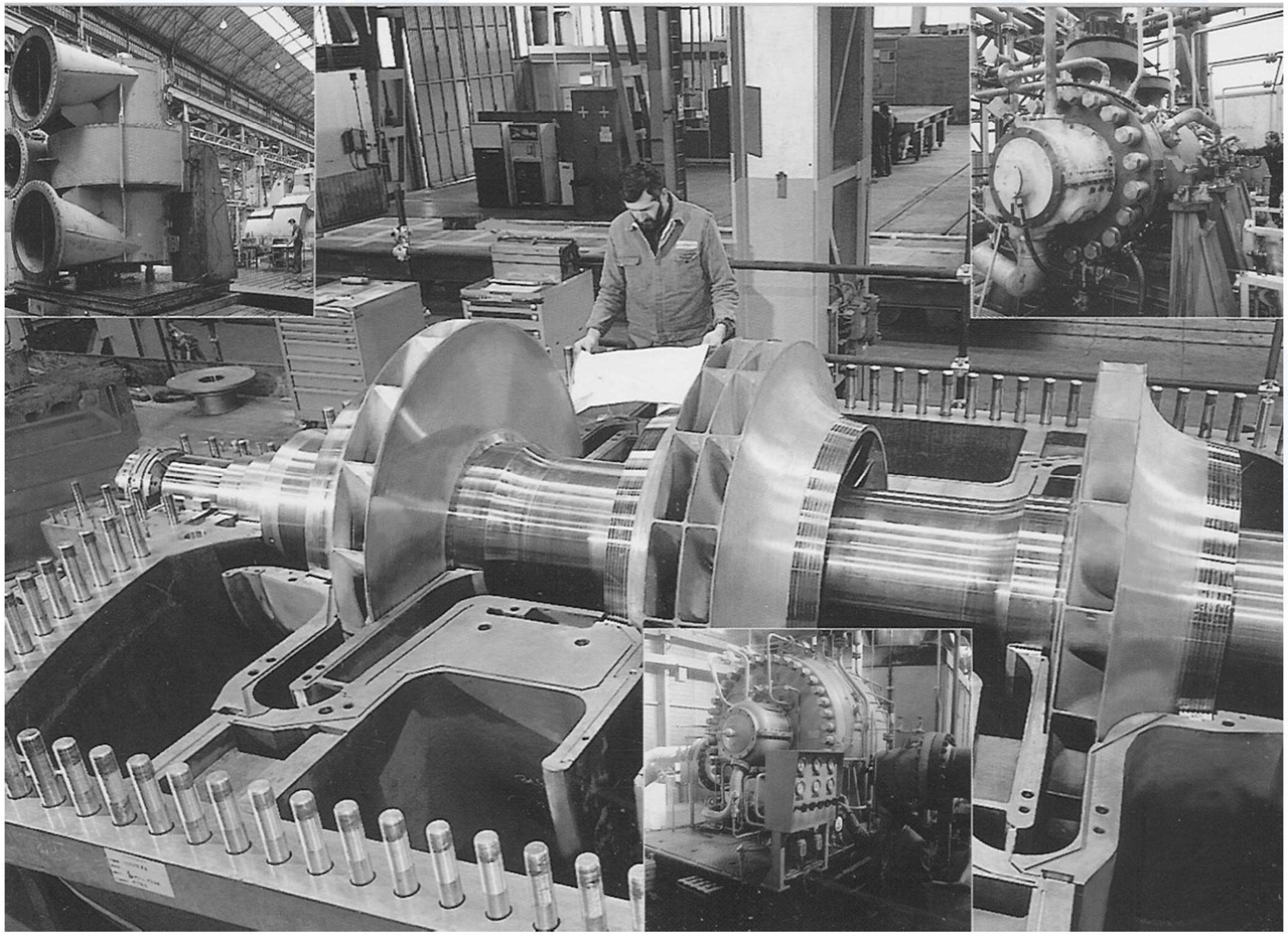
API Standard 617 requires steel casings for the following conditions:

1. Gas pressure above 17.5 barg [250 psig].
2. Flammable or toxic gas at a pressure over 5.25 barg [75 psig].
3. Gas gaining compression heat above 232°C [4500000F]
4. Flammable or toxic gas gaining compression heat above 177ºC [350ºF].



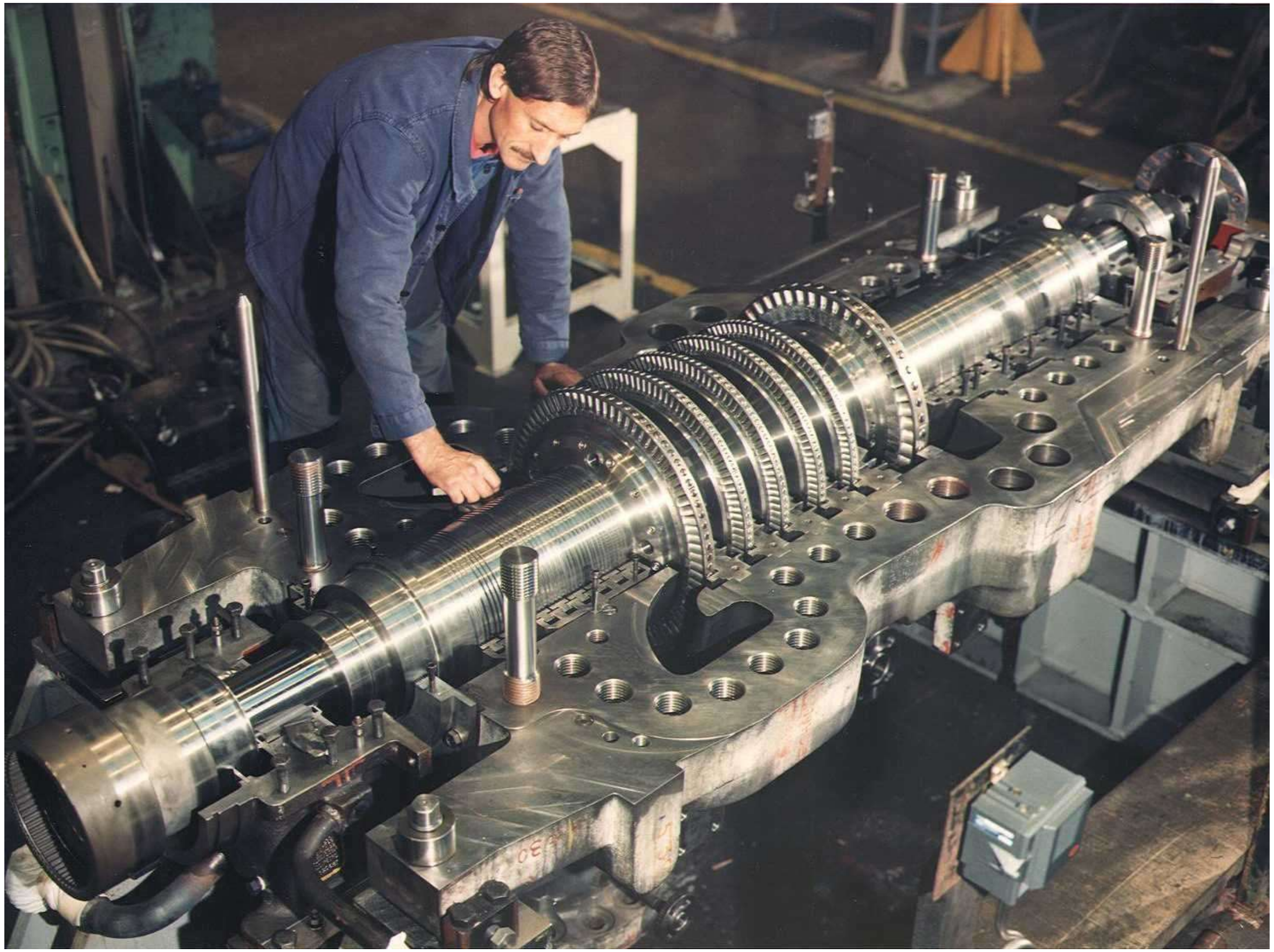
Horizontally split casing

For high stress or low temperature conditions, a variety of alloys are available.
Where corrosion is expected, the casing may be made with extra thickness. When severe corrosion is expected, corrosion resistant alloys, such as stainless steel and chromium, are used in both the casing and internals.



Horizontally split casing

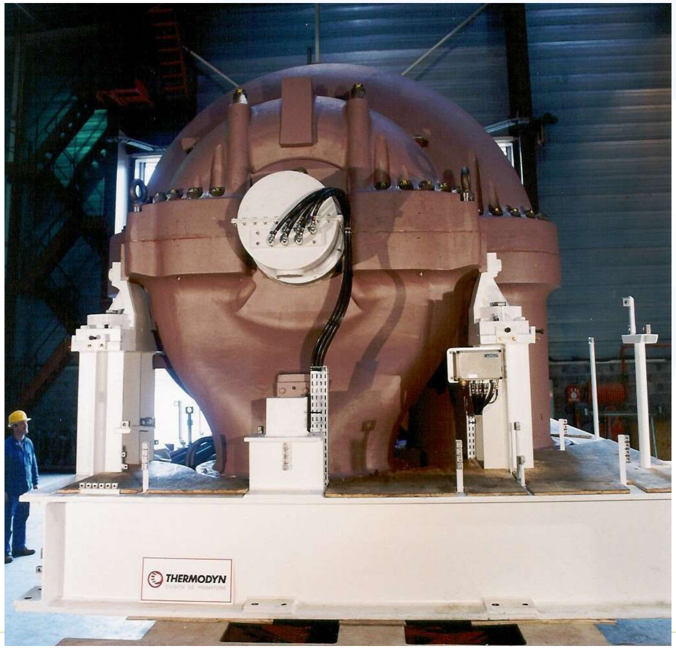
Casing drains can be installed at the bottom of each impeller volute. These are simply a tapped, flanged or threaded opening connected to a gate valve.
The casing flanges on a horizontally-split machine have a pressure limitation of about 50 barg [700 psig]. Lower pressure limitations apply to extra large units, or those handling hydrogen, which leaks through the horizontal gasket.

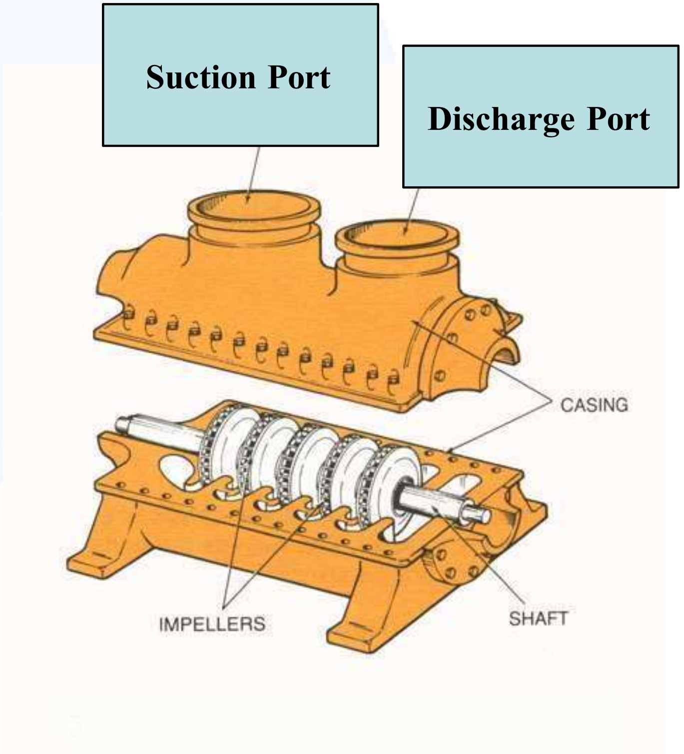


Horizontally split casings (MCL, 2MCL, 3MCL, DMCL)

Both half -casings are obtained from conventional castings.
The material is chosen depending on operating pressure and temperature, size , gas handled, and regulations provided by APL standards .
Generally Nuovo Pignone use Meehanite GD cast iron with 25-30 kg/mm2 tensile strength and 70 Kg/mm2 compressive strength (i. e. best than many steels).

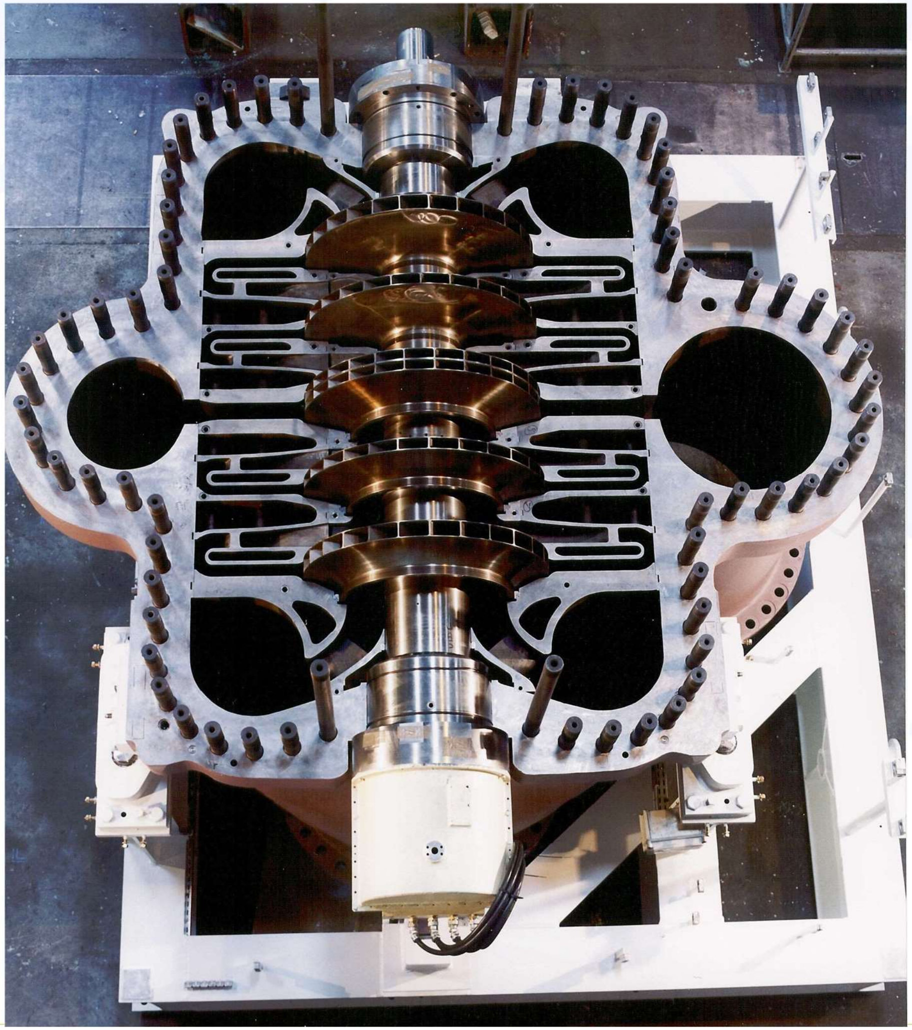
When steel has to be used t o cast these casings,ASTM A 216 WCA steel is utilized ; should the compressor operate a t low temperatures ASTM A 352 steel is used i n one of its four grades depending on the operating temperature; lastly , we use ASTM 351 Gr .
CAI5 steel (13% C r) or Gr . CF8 in case of corrosive media.





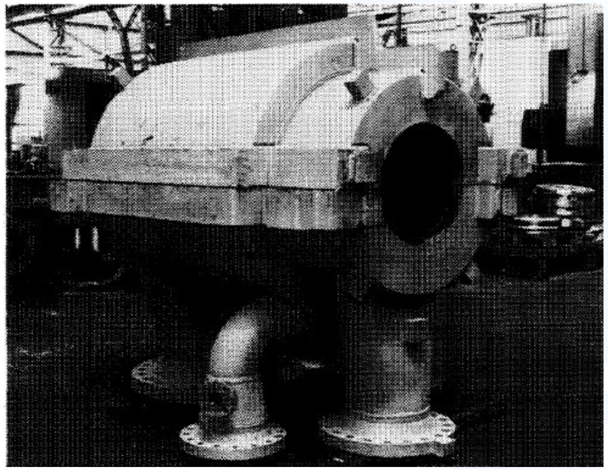
Horizontally split casings (MCL, 2MCL, 3MCL, DMCL)

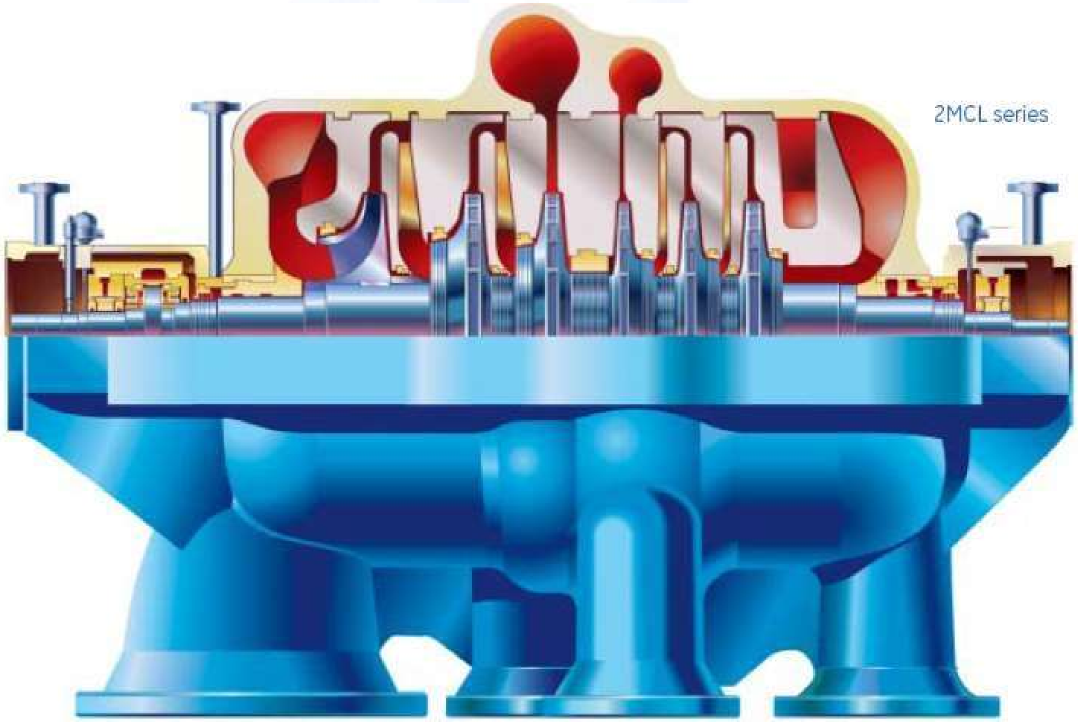
The usual test these castings undergo is the magnetic particle inspection. In particular cases, when a more careful check is required, the ultrasonic test is carried out.
Sometimes the radiografic inspection is required; we do not consider it useful as stresses affecting these elements are limited and the flaws surely exist in castings , yet acceptable and not detrimental to such castings , can be displayed in this way.



Horizontally split casing

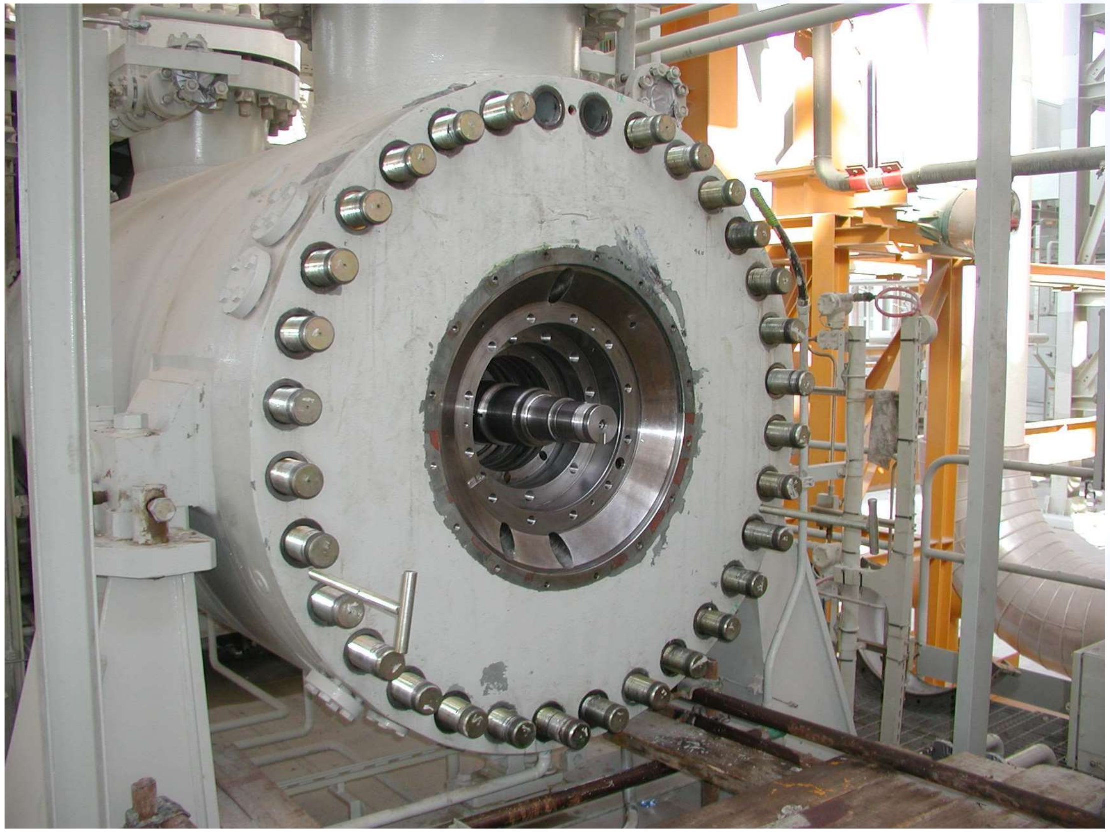
The latest tendency is to use welded casings , this solution being more advantageous than casting : in this way danger of rejections , repairs etc., is reduced, avoiding to lay models aside , which calls for large room and great care in case of diversified production line such at Nuovo Pignone's, to prevent any damage to them.

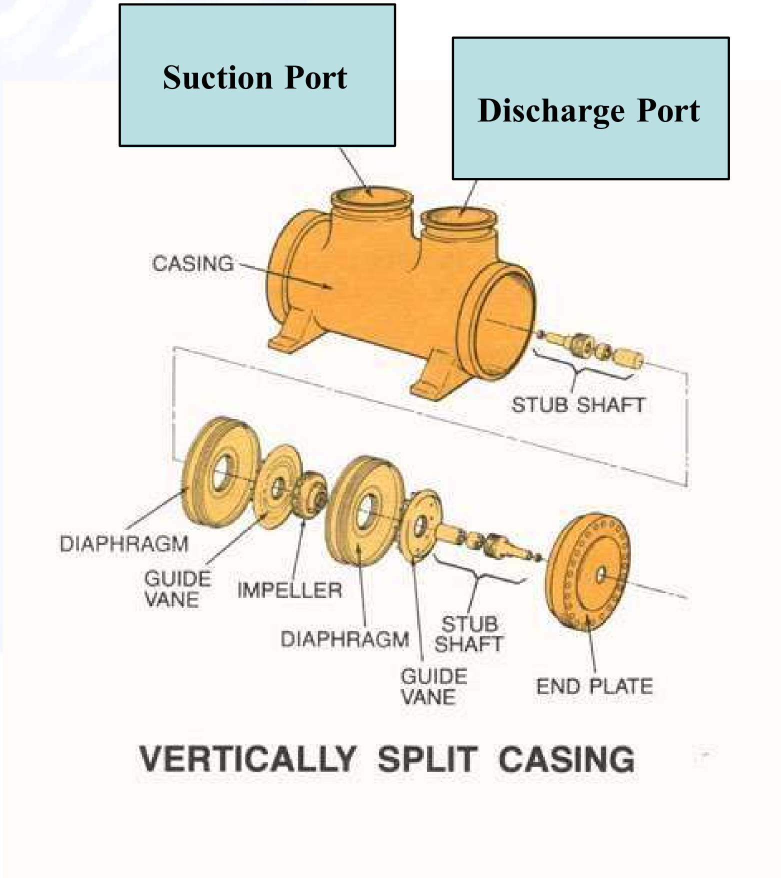




Vertically split casing (or barrel type)

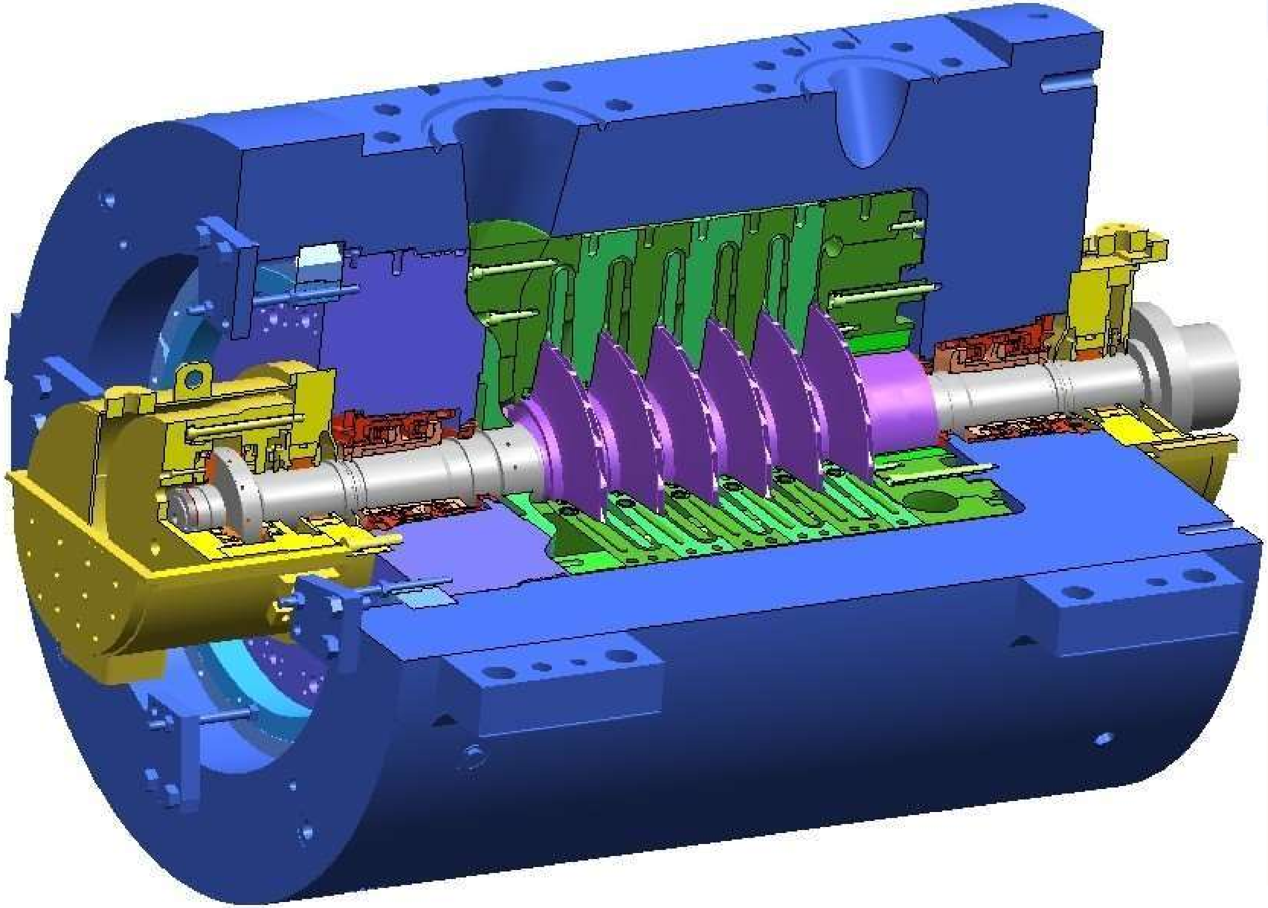
A *vertically-split* type casing (sometimes called a "barrel") is used for higher pressure services. It is a forged or cast steel cylinder made to withstand the discharge pressure. The bolts holding the end plate to the casing form a vertical line.

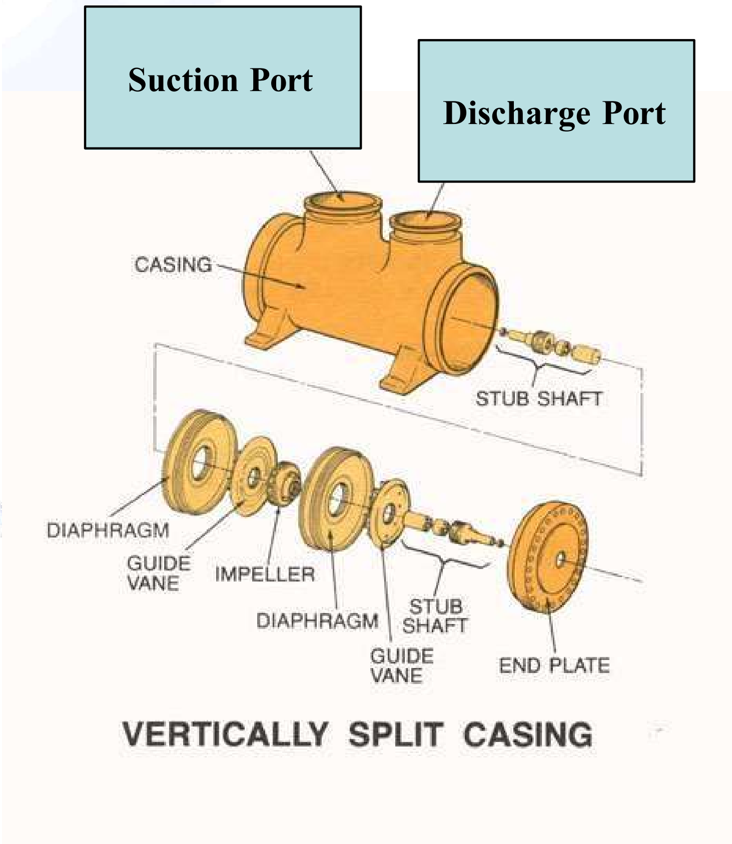




Vertically split casing (or barrel type)

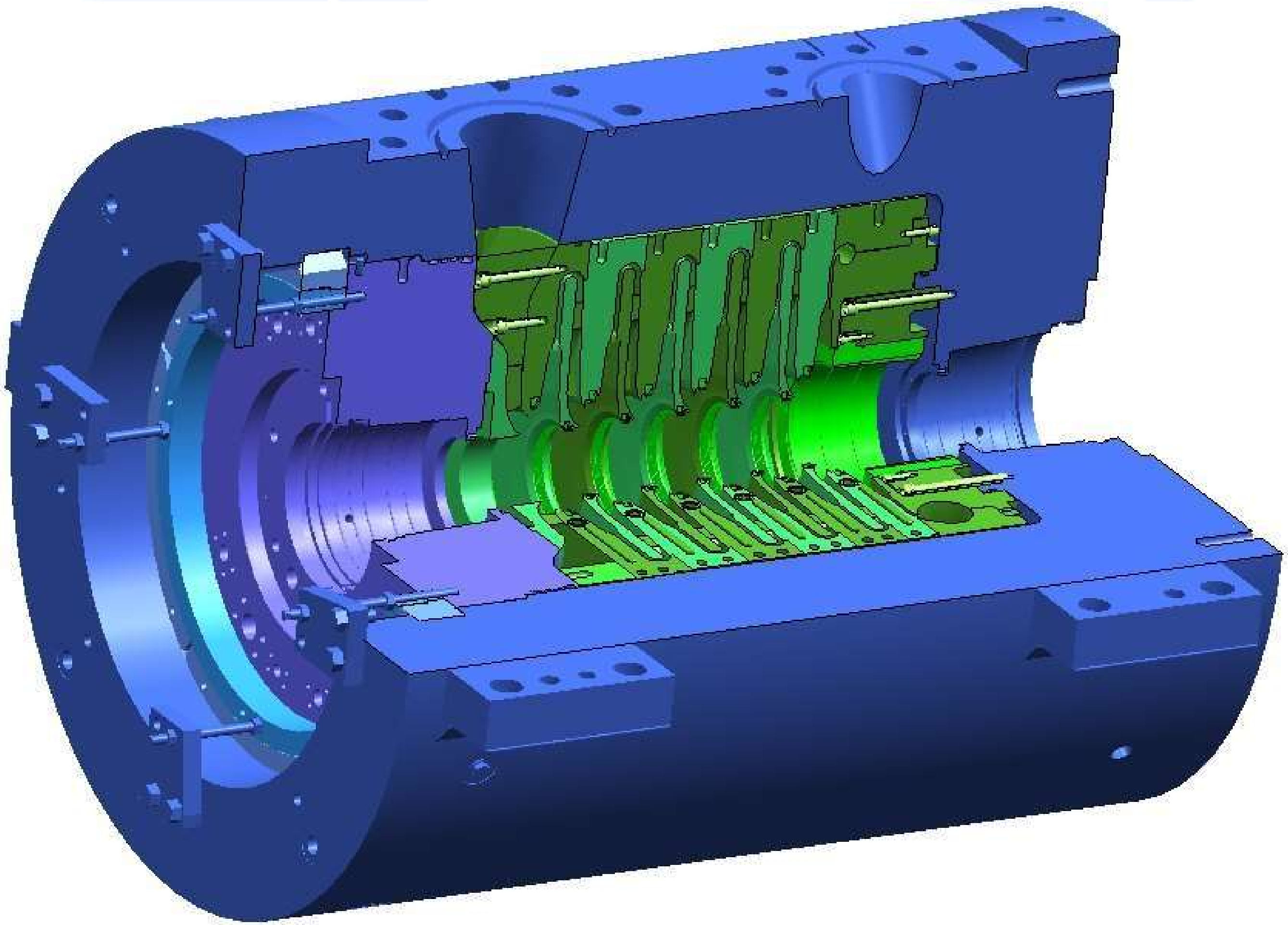
The cylindrical, symmetrical casing design provides high strength. Changes in metal dimensions caused by temperature rise are also symmetrical and relatively equal, eliminating large stress and distortion encountered in other types of compressor cases. Heavy forged end covers, or plates, can be made for both ends or just one, depending upon the design .





Vertically split casings (BCL, 2BCL, PCL)

Both casings and end covers are obtained from forgings so that material might be as homogeneous as possible, hence more resistant , taking account of the high pressures these compressors have to meet with.



Vertically split casings (BCL, 2BCL, PCL)

ASTM A 105 Gr . I1 carbon steel is generally used for the barrel , supports and end covers: the carbon content applied (0.2-0.25% instead of 0.35 as per tables) is enough to get good mechanical characteristics thus granting also characteristics of weldability.

Alloy steel with higher mechanical characteristics is used for compressors running under very high pressure (BCL/c, BCL/d).

Suction and discharge nozzles are welded t o the casing, generally forged i n the same material; as to PCL's, owing t o their complicated structure hence not suited t o be forged , another material is used for casing.