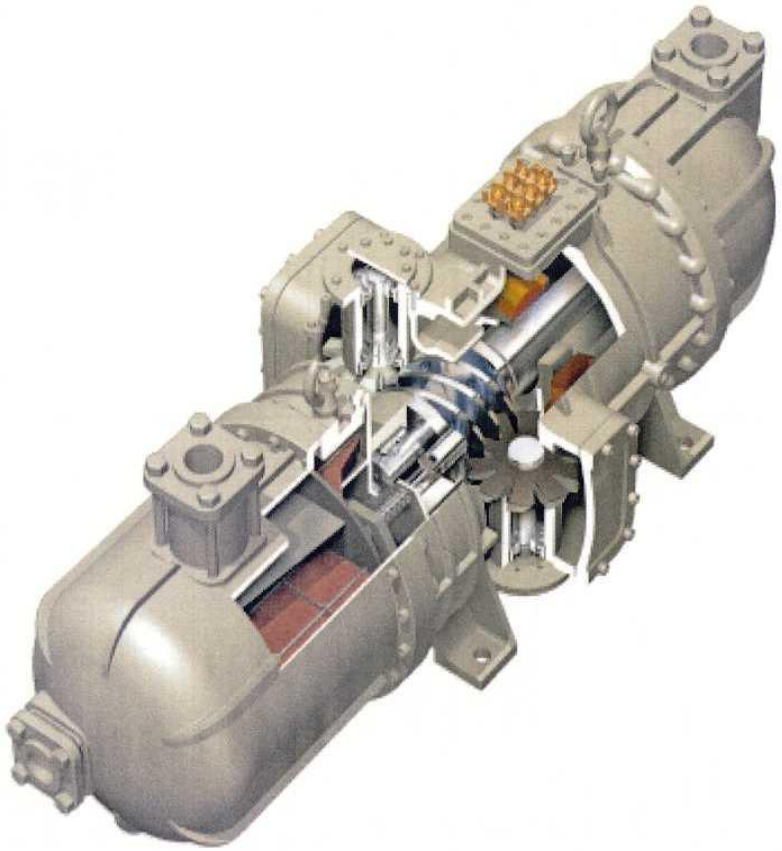
Single screw compressor presentation

Working principle & inspection guidelines

Daikin Single G-type Screw Compressor



R134a

Up to 90 KW120 Hp

R407C

Up to 135KW/180 Hp

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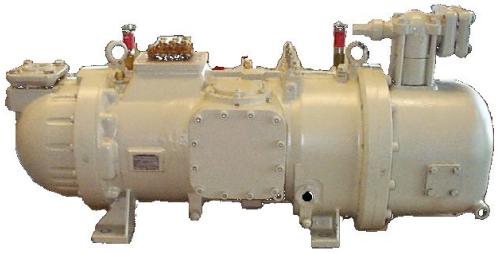
Stepless Single Screw Compressor

History

step control



F-type

step control

G-type

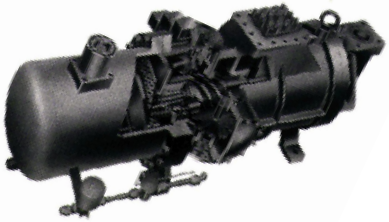
G-type stepless

time

2000 — 2003 — 2005

1988

ZH13L & ZH15L



Robustness, reliability = Robustness, reliability

Performance = Performance

Dimensions = Dimensions

Limited control (stepped) ≠Extended control (stepless)

The stepless compressor is a DAIKIN development !

Designed, tested and manufactured in Daikin's own laboratories.

*

G type compressor

- Nomenclature

ZH	A	5	L	M	C	W	YE	R

Semi-hermetic screw compressor

Refrigerant
None :R22
A :R134a
C :R407C

Approximate of screw diameter
(mm×1/10,omit 1)

Gate rotor size
Parallel shape
L large
U
M
N
S small
fan shape
W:large
V :small

Length of screw
L : long
M : middle
S : short
T : more short

G-type

Use
None : both for air and water cooled chiller (STEP)
W : for water cooled chiller (STEP)
U : both for air and water cooled chiller (STEPLESS)

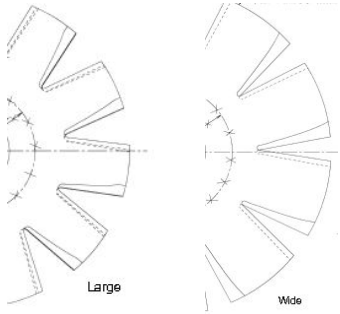
Power source
(Shown in table 1)

For special use

Table 1 Power source

Symbol	Power source	
None	200/220V	50/60Hz
TC	200	60Hz
TE	200~240/220	50/60Hz
TH	240V	60Hz
YE	380~415/440	50/60Hz
YB	400~440	60Hz
YH	346~380/380~400	50/60Hz
YR	415~440/440~480	50/60Hz

3-5-7-9 sizes



G, G4 = step

GU,G5, G6 =Stepless

*

G type compressor with step control

G-type step range from 30KW to 135 KW

I -1.Step Capacity Control Model

GENERAL DATA (Refrigerant R22,R407C)

MODEL		R22 / R407C	ZH3LTG / ZHC3LTG	ZH3WLG / ZHC3WLG	ZH5LMG / ZHC5LMG	ZH5WLG / ZHC5WLG	ZH7LSG / ZHC7LSG	ZH7WSG / ZHC7WSG	ZH9LSG / ZHC9LSG	ZH9WSG / ZHC9WSG
Screw Diameter		mm	132		147		175		196	
Gate Rotor Diameter		mm	135	135(Wide)	154	154(Wide)	183	183(Wide)	203	203(Wide)
Displacement	50Hz	m^3/h	123.20	158.72	189.06	239.87	302.96	365.92	420.53	536.75
	60Hz	m^3/h	148.44	191.23	227.79	289.01	365.02	440.88	506.68	646.71
Capacity Control Step		%	100,70,40,12(starting position)						100,70,40,25,12(starting position)	
Refrigeration Oil		—	SUNISO 4GSD for R22 / FVC68D for R407C							
Oil Charged		Liter	5.5		7.5		10		14	
Motor Type		—	2Pole,3Phase Induction Motor							
Motor Revolution	50Hz	rpm	2880							
	60Hz	rpm	3470							
Rated Output		kW(HP)	30(40)	37(50)	45(60)	60(80)	75(100)	90(120)	110(150)	135(180)
Power Supply		V(Hz)	*Note)			380~415/380~440(50/60Hz)				
Net Weight		kg	355	365	445	460	570	595	760	790
Airtight Pressure (Design Pressure)		MPa	2.8(ZHC:2.98)							
Hydrostatic Pressure		MPa	4.2(ZHC:4.47)							

GENERAL DATA (Refrigerant R134a)

MODEL		ZHA5LMG / ZHA5WLG	ZHA7MSG / ZHA7WSG	ZHA9LSG / ZHA9WSG
Screw Diameter	mm	147	175	196
Gate Rotor Diameter	mm	154	154(Wide)	175	183(Wide)	203	203(Wide)
Displacement	50Hz	m^3/h	189.06	239.87	270.42	365.92	420.53	536.75
	60Hz	m^3/h	227.79	289.01	325.82	440.88	506.68	646.71
Capacity Control Step	%	100,70,40,12(starting position)				100,70,40,25,12(starting position)	
Refrigeration Oil	—	FVC68D					
Oil Charged	Liter	7.5		10		14	
Motor Type	—	2Pole,3Phase Induction Motor					
Motor Revolution	50Hz	rpm	2880				
	60Hz	rpm	3470				
Rated Output	kW(HP)	30(40)	37(50)	45(60)	60(80)	75(100)	90(120)
Power Supply	V(Hz)	*Note)			380~415/380~440(50/60Hz)		
Net Weight	kg	425	440	515	540	690	730
Airtight Pressure (Design Pressure)	MPa	2.0					
Hydrostatic Pressure	MPa	3.0					

*Note)
200~240/200~220 or
380~415/380~440(50/60Hz)

*

G type compressor with stepless control

G-type stepless range from 30KW to 135 KW

Ⅰ-2.Stepless Capacity Control Model

GENERAL DATA (Refrigerant R22,R407C)

MODEL		R22	ZH3LTGU	ZH3WLGU	ZH5LMGU	ZH5WLGU	ZH7LSGU	ZH7WSGU	ZH9LSGU	ZH9WSGU
		R407C	ZHC3LTGU	ZHC3WLGU	ZHC5LMGU	ZHC5WLGU	ZHC7LSGU	ZHC7WSGU	ZHC9LSGU	ZHC9WSGU
Screw Diameter		mm	132		147		175		196	
Gate Rotor Diameter		mm	135	135(Wide)	154	154(Wide)	183	183(Wide)	203	203(Wide)
Displacement	50Hz	m³/h	123.20	158.72	189.06	239.87	302.96	365.92	420.53	536.75
	60Hz	m³/h	148.44	191.23	227.79	289.01	365.02	440.88	506.68	646.71
Capacity Control		%	100~30, 0(starting position)							
Refrigeration Oil		—	SUNISO 4GSD for R22 / FVC68D for R407C							
Oil Charged		Liter	5.5		7.5		10		14	
Motor Type		—	2Pole,3Phase Induction Motor							
Motor Revolution	50Hz	r p m	2880							
	60Hz		3470							
Rated Output		kW(HP)	30(40)	37(50)	45(60)	60(80)	75(100)	90(120)	110(150)	135(180)
Power Supply		V(Hz)	*Note)		380~415/380~440(50/60Hz)					
Net Weight		k g	358	368	448	463	573	598	763	793
Airtight Pressure(Design Pressure)		MPa	2.8(ZHC:2.98)							
Hydrostatic Pressure		MPa	4.2(ZHC:4.47)							

GENERAL DATA (Refrigerant R134a)

MODEL		ZHA5LMGU	ZHA5WLGU	ZHA7MSGU	ZHA7WSGU	ZHA9LSGU	ZHA9WSGU
Screw Diameter	mm	147		175		196	
Gate Rotor Diameter	mm	154	154(Wide)	175	183(Wide)	203	203(Wide)
Displacement 50Hz	m³/h	189.06	239.87	270.42	365.92	420.53	536.75
Displacement 60Hz	m³/h	227.79	289.01	325.82	440.88	506.68	646.71
Capacity Control	%	100~30, 0(starting position)					
Refrigeration Oil	—	FVC68D					
Oil Charged	Liter	7.5		10		14	
Motor Type	—	2Pole,3Phase Induction Motor					
Motor Revolution 50Hz	r p m	2880					
Motor Revolution 60Hz		3470					
Rated Output	kW(HP)	30(40)	37(50)	45(60)	60(80)	75(100)	90(120)
Power Supply	V(Hz)	*Note)		380~415/380~440(50/60Hz)			
Net Weight	k g	428	443	518	543	693	733
Airtight Pressure(Design Pressure)	MPa	2.0					
Hydrostatic Pressure	MPa	3.0					

*Note)
200~240/200~220 or
380~415/380~440(50/60Hz)

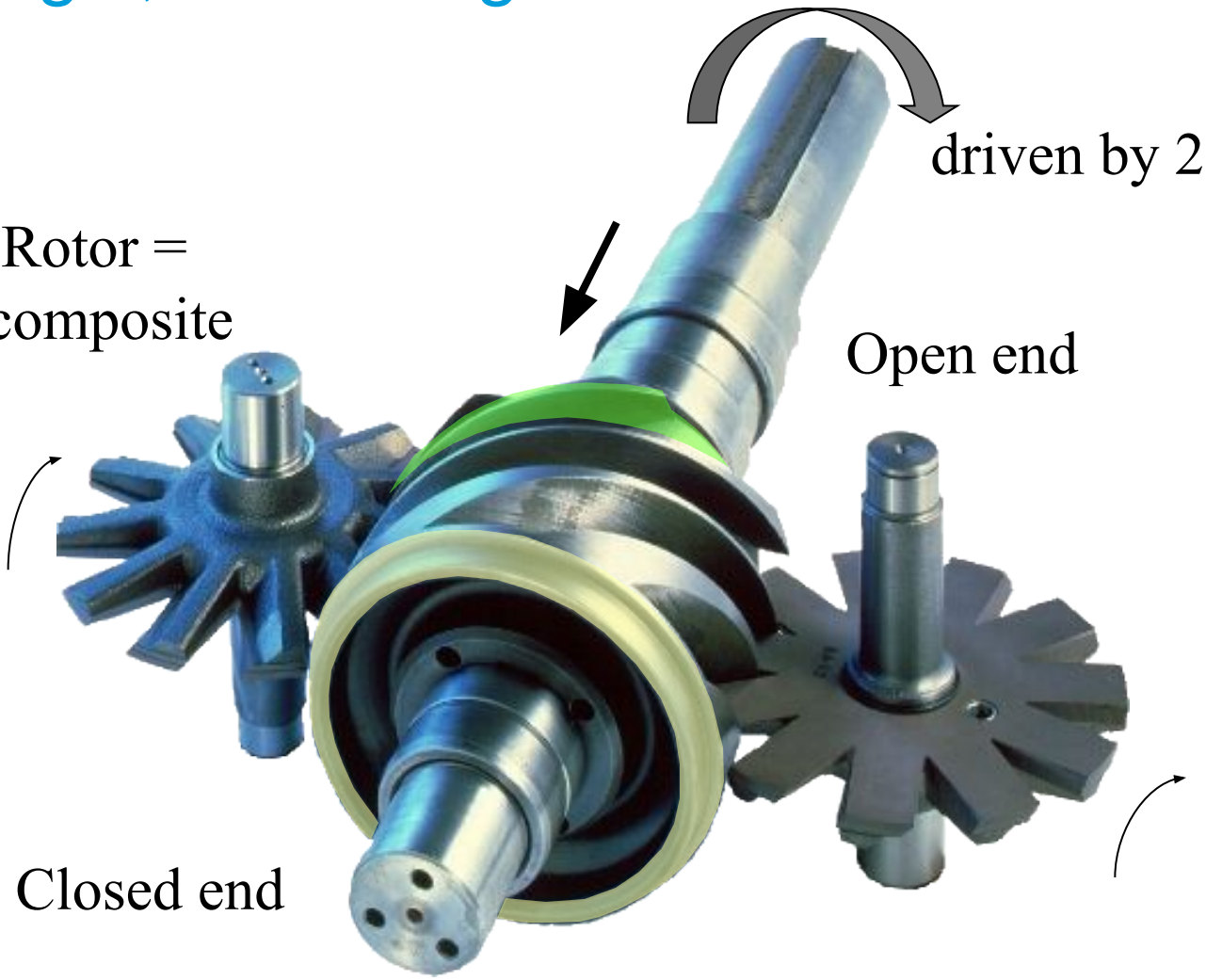
*

The single, mono or globoïd screw

Satelite
Or Gate Rotor =
Special composite
material

driven by 2-pole motor

Open end

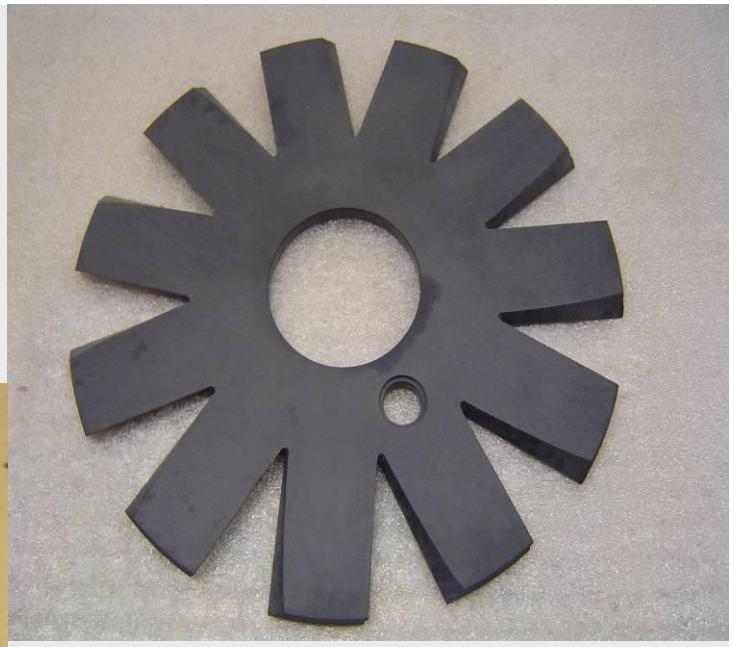


Closed end

12 x 2900 = 34,800 compressions per minute = continuous flow !

*

Gate rotor and gate rotorshaft



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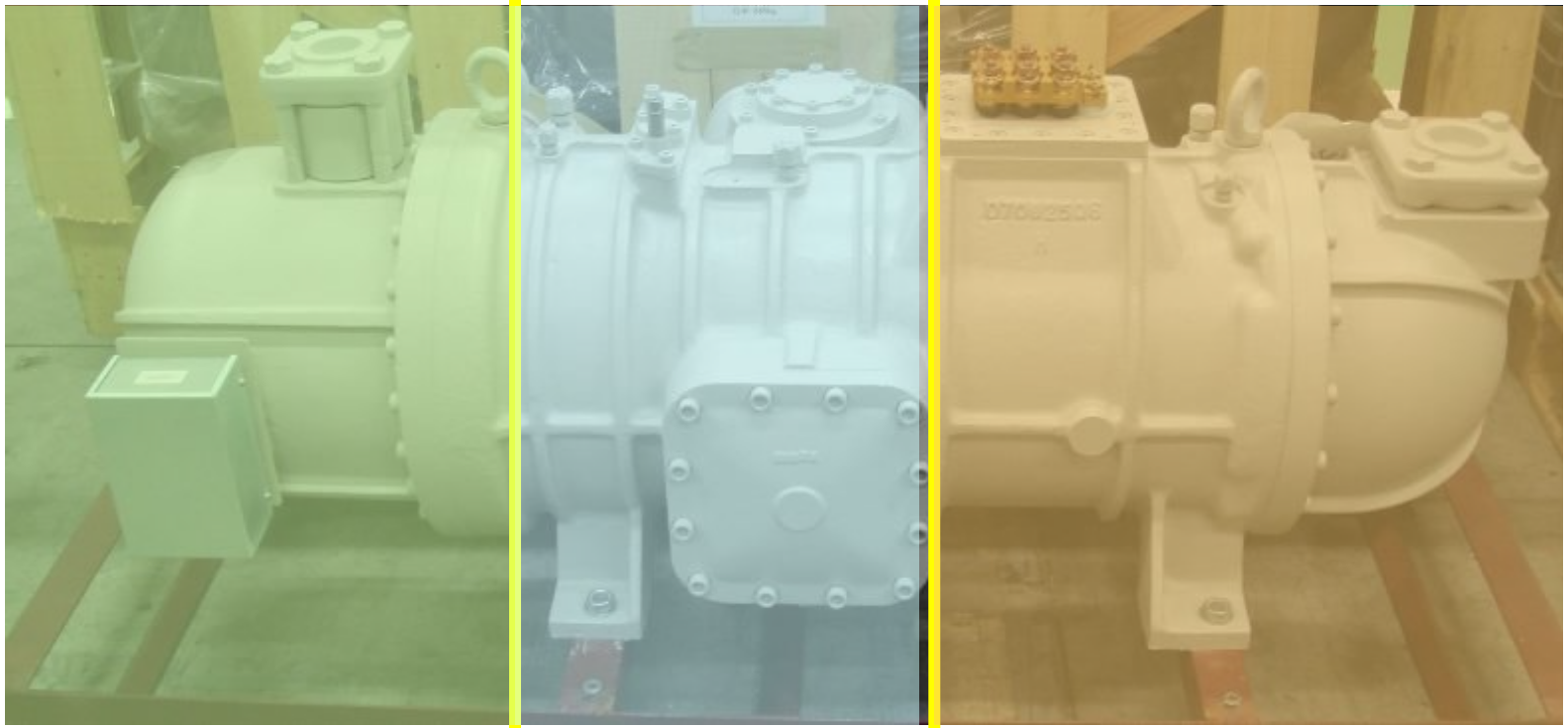
The G-type screw compressor

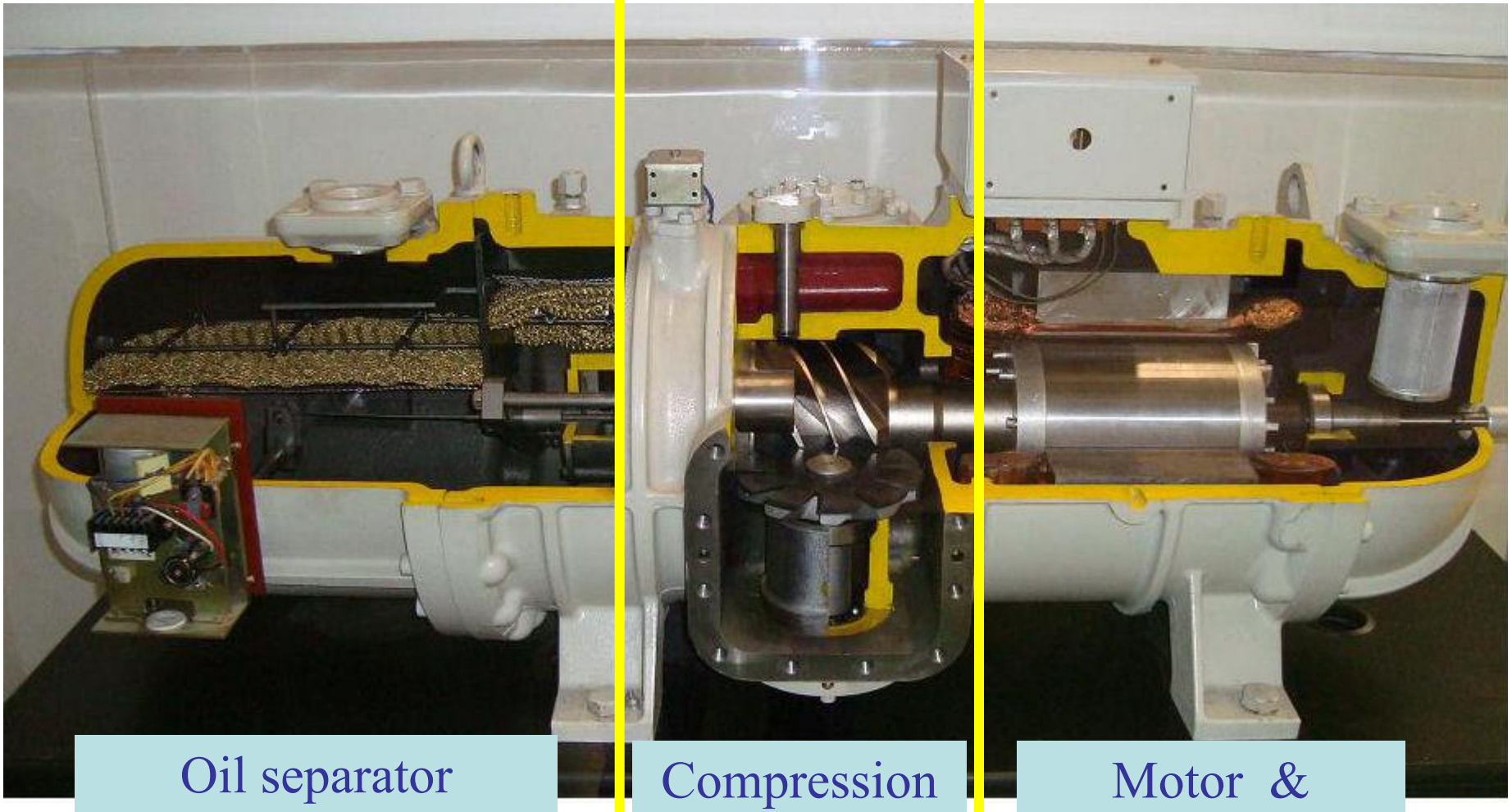


Oil separator & capacitycontrol

Compression section

Motor & suction section

The Heart of the single screw compressor



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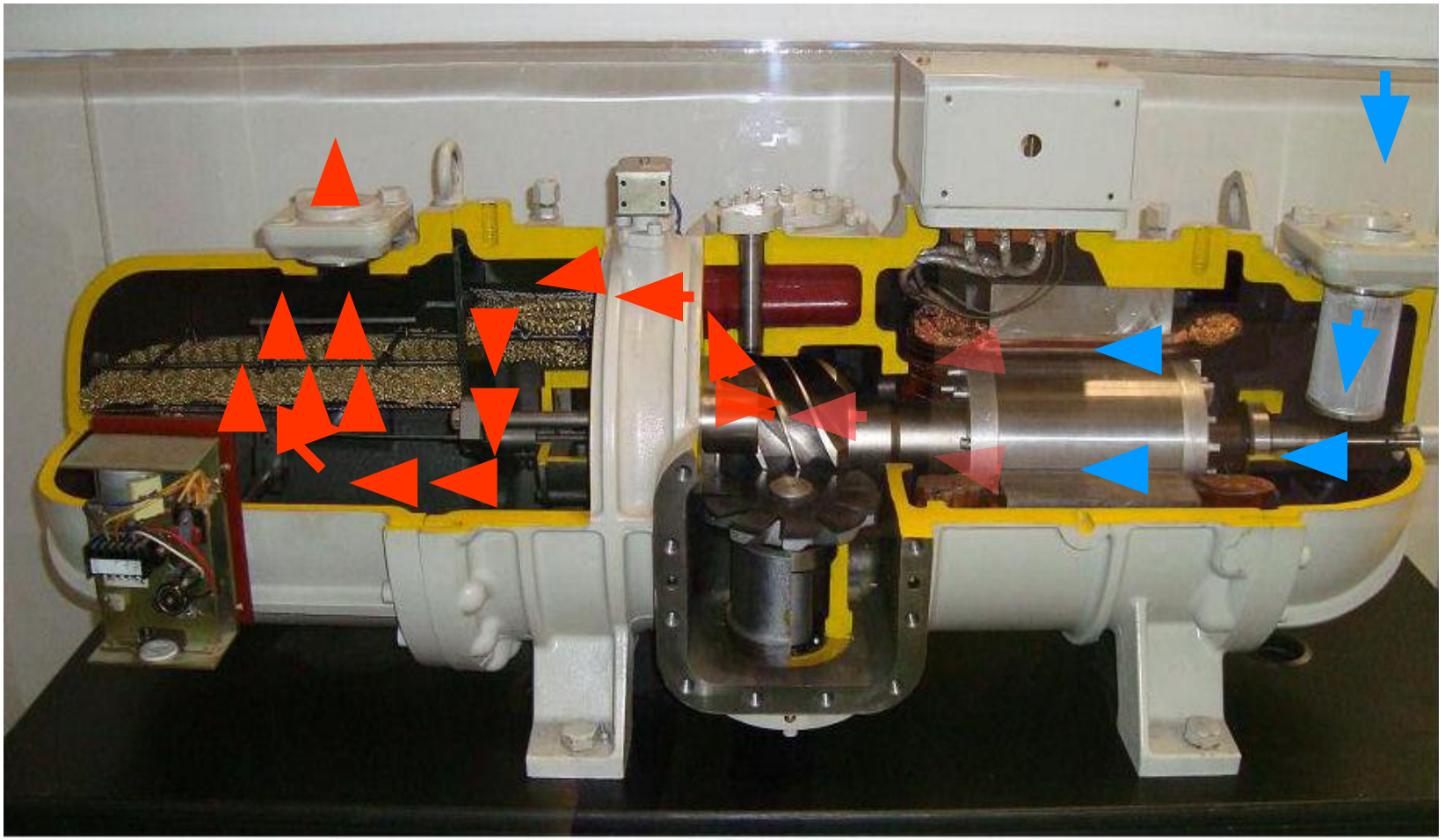
The flow inside compressor



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Compression Principle

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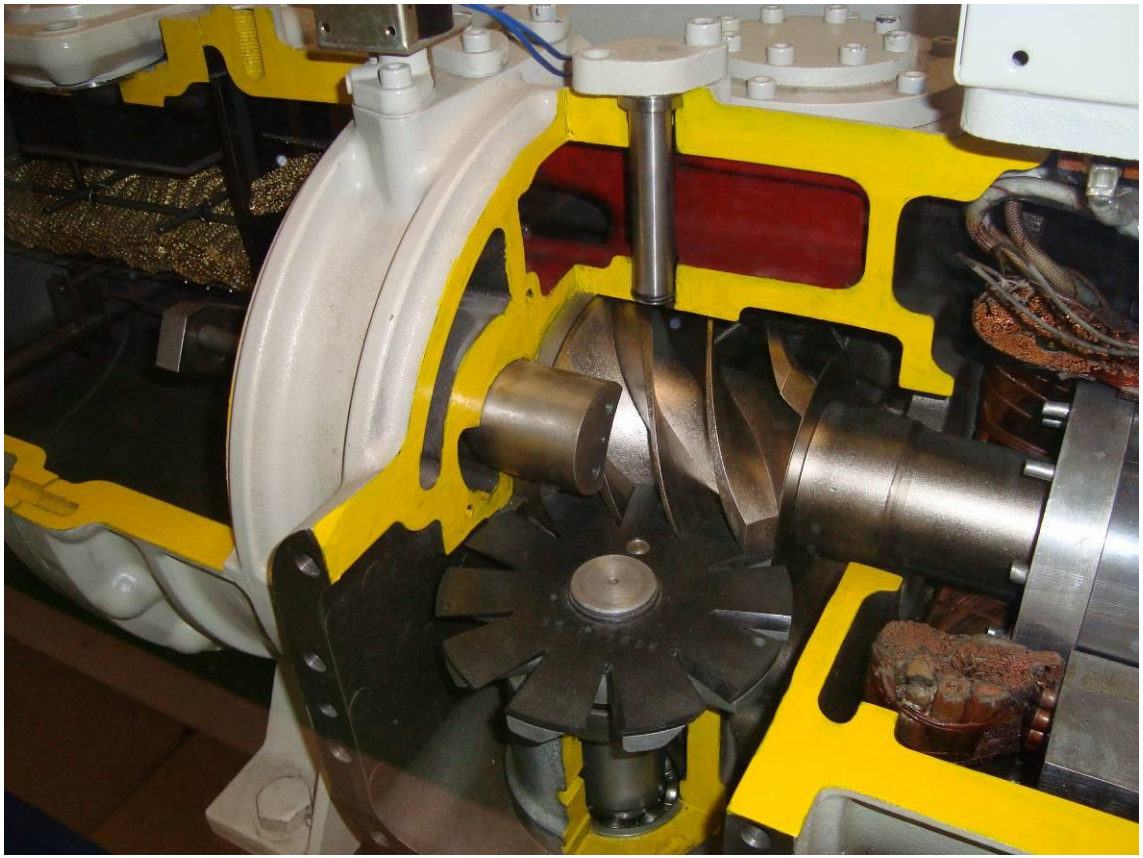
G-type screwcompressor

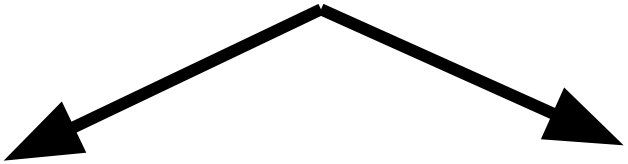
Anim.

- Compression principle



Capacity adjustment design

Loading & Unloading Mechanism



G types until 2005

step control

3 to 4 fixed capacity steps

F types

G types from 2005

stepless control

Continuous control between 30 and 100%

*

Capacity adjustment design step

Step control

Principle

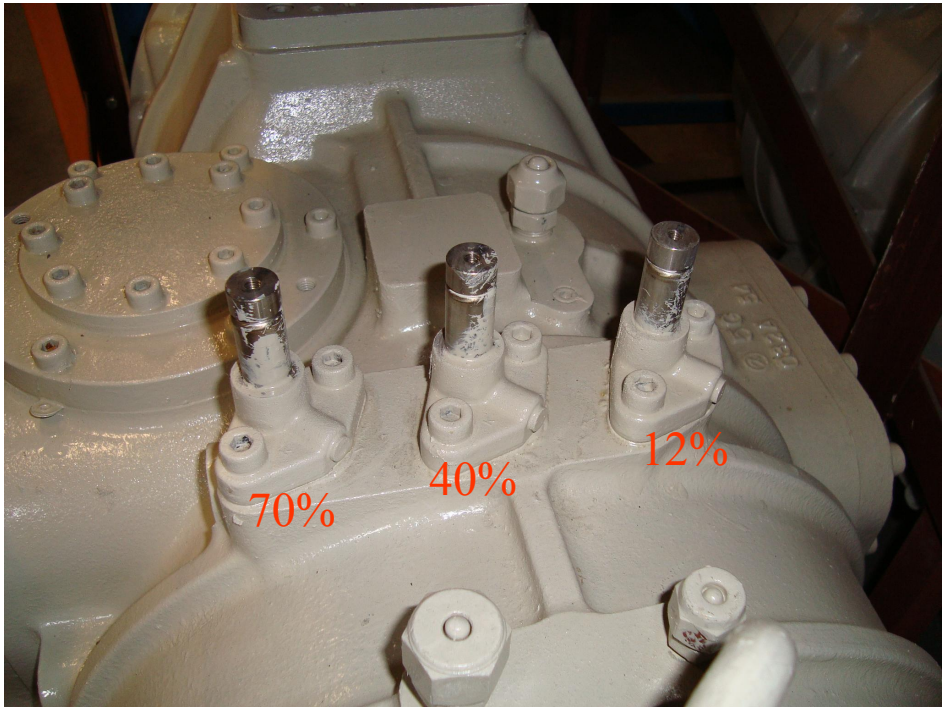
Is based on internal pressure differences

Selection of capacity step with solenoid valves

*

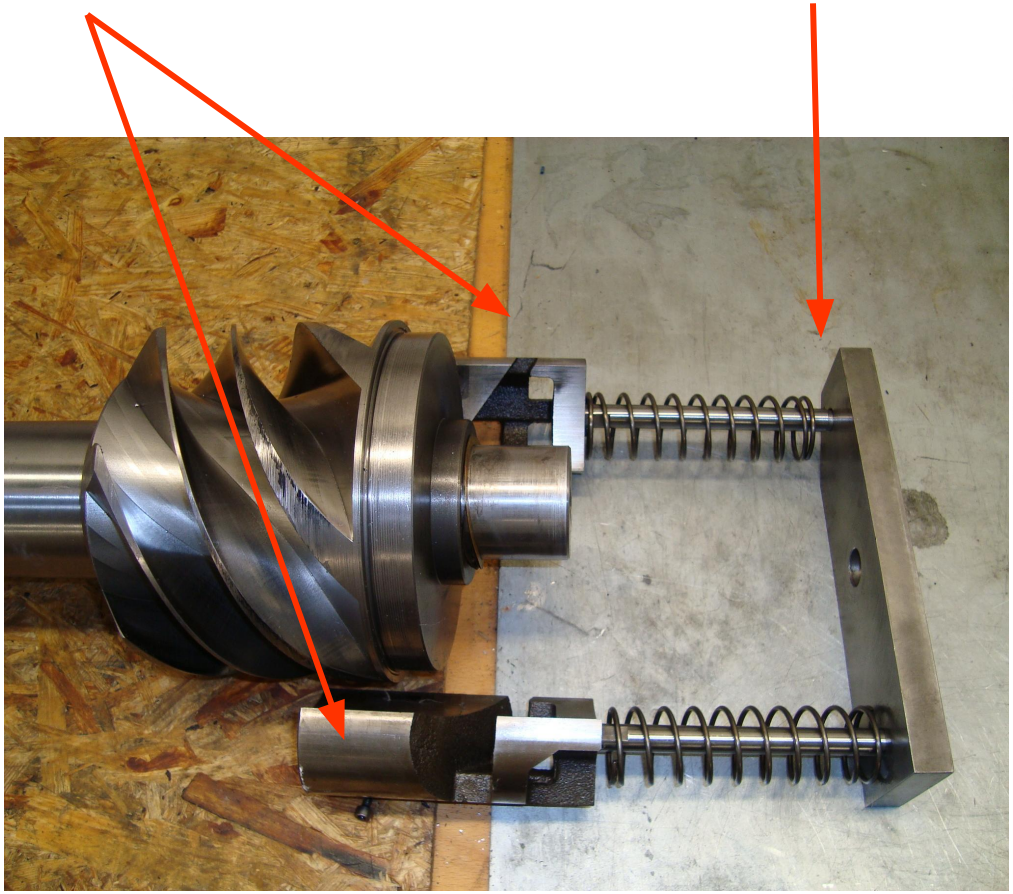
step control/essential parts

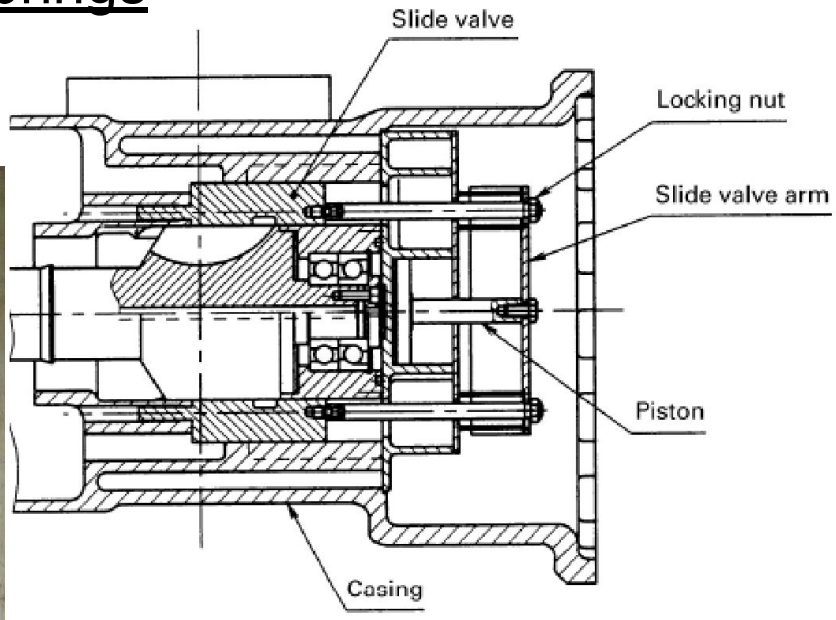
- Capacity solenoid valves



step control/essential parts

- Sliding vanes with bridge and springs





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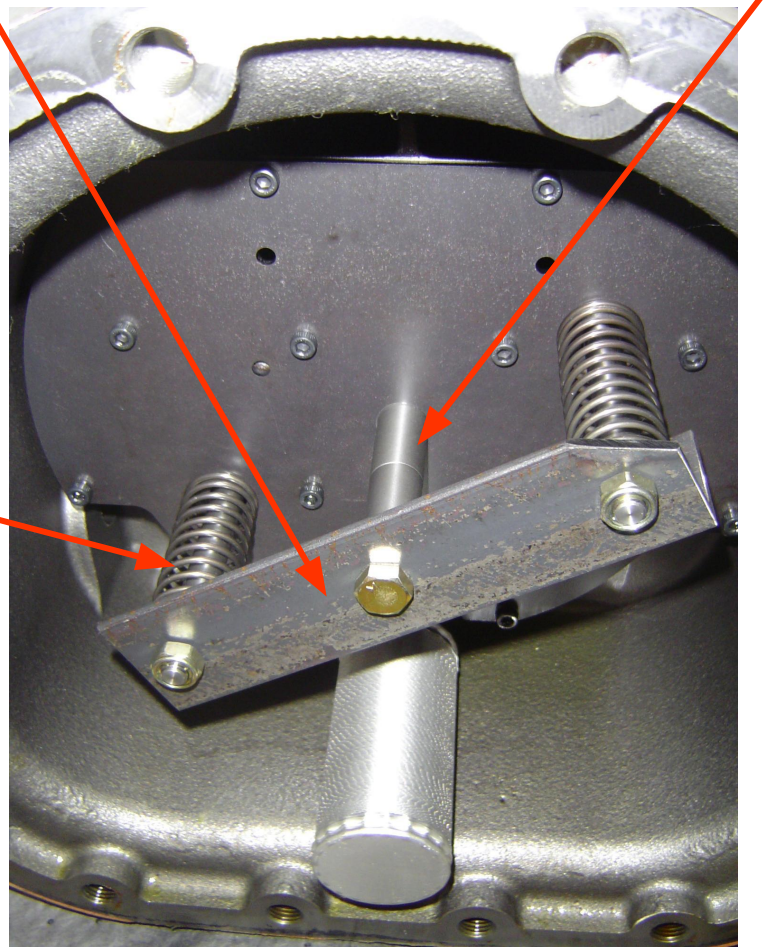
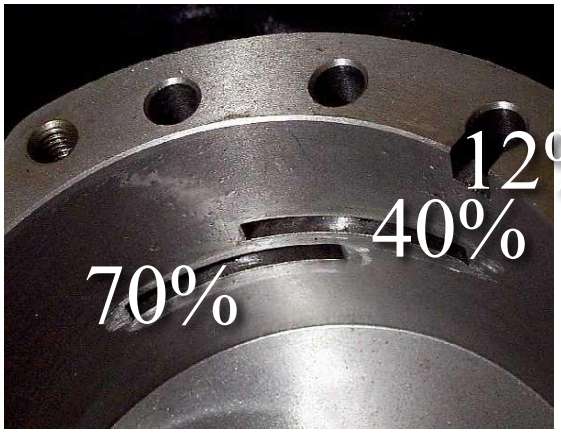
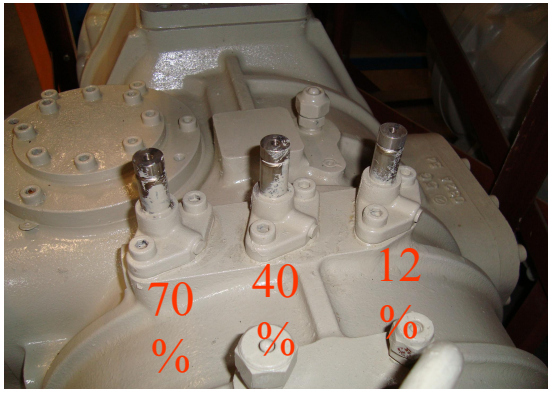
step control/essential parts

- Slide vane bridge with capacity cylinder/piston

Springs







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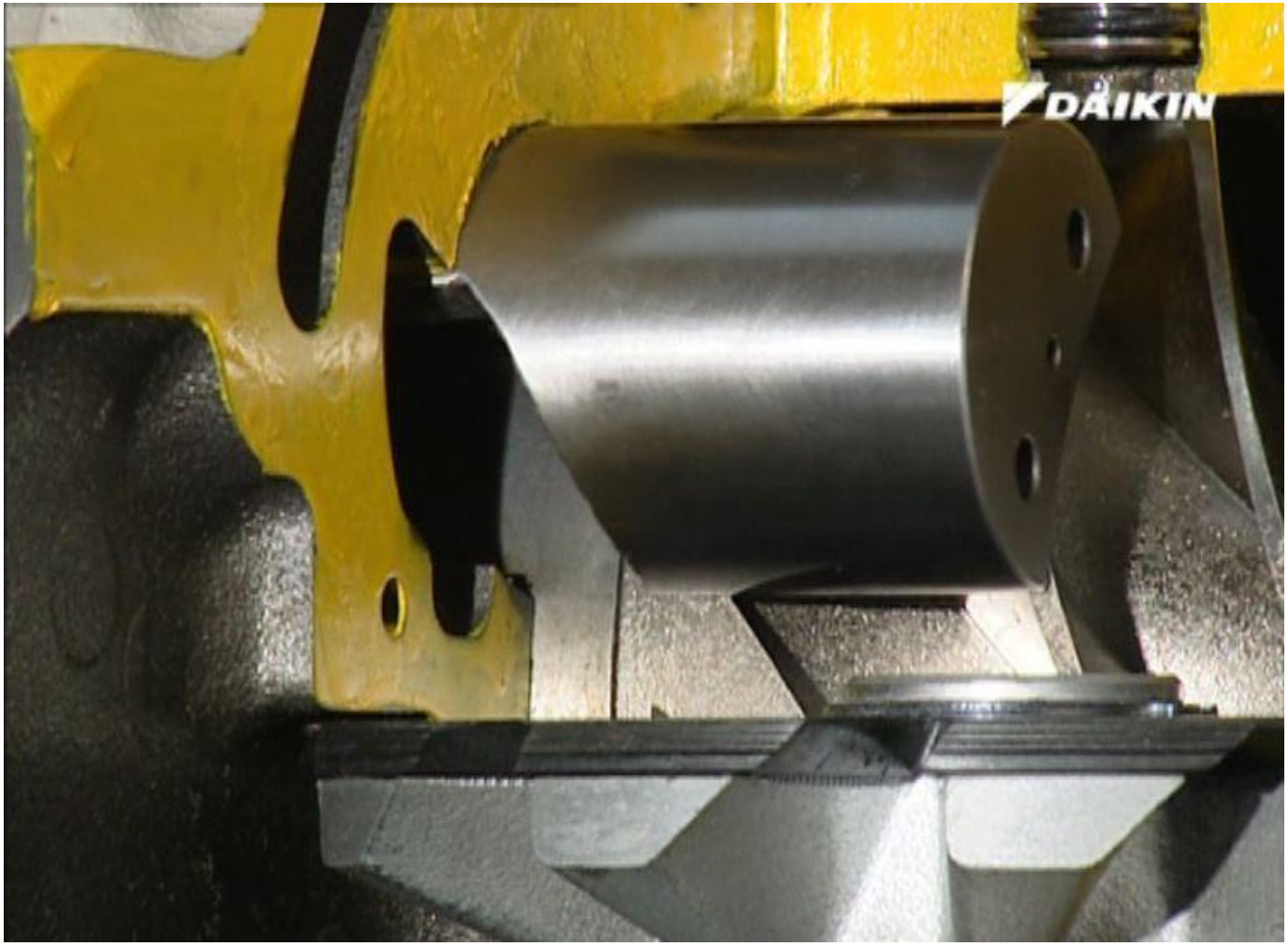
Capacity adjustment design

Anim.



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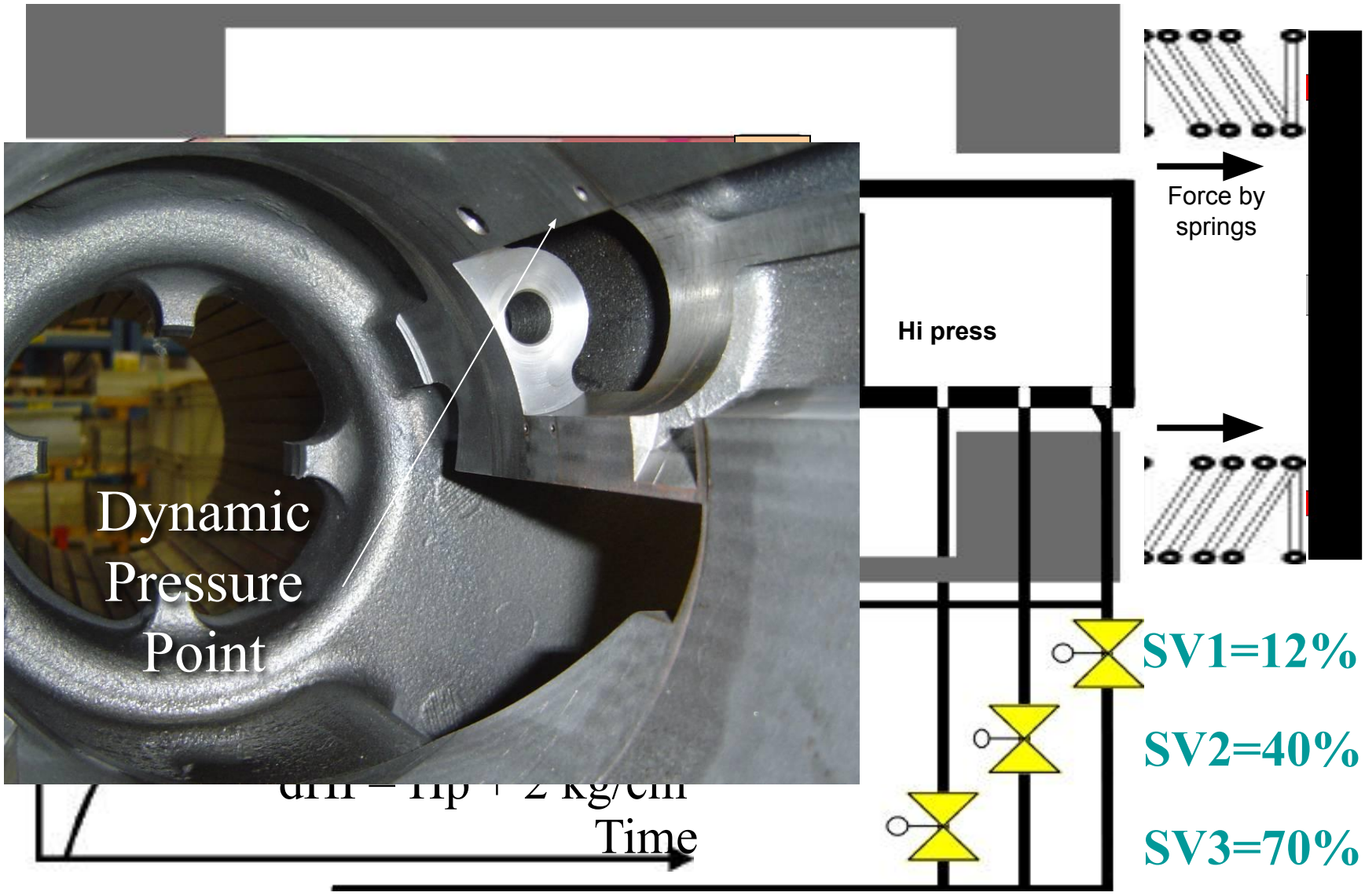
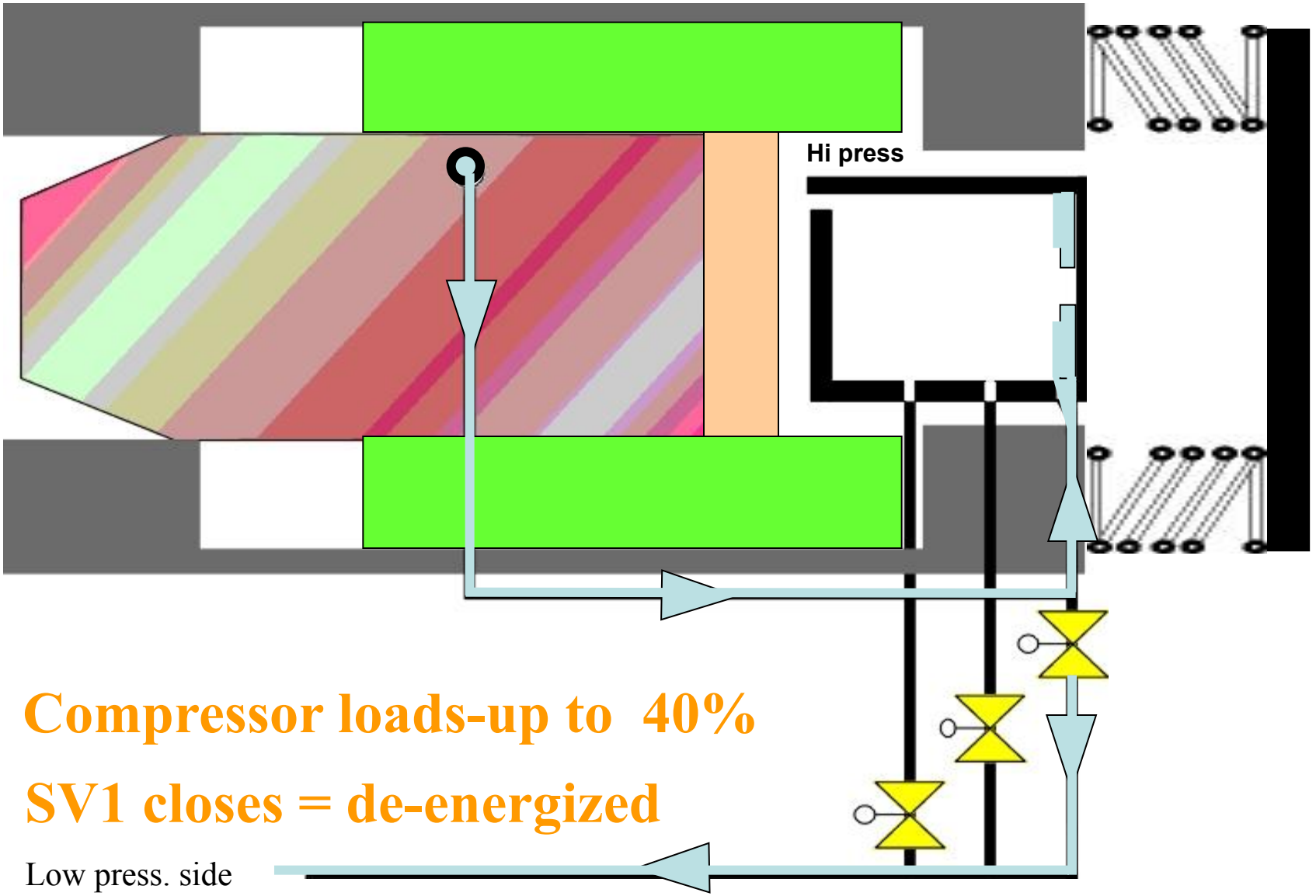
Step control system



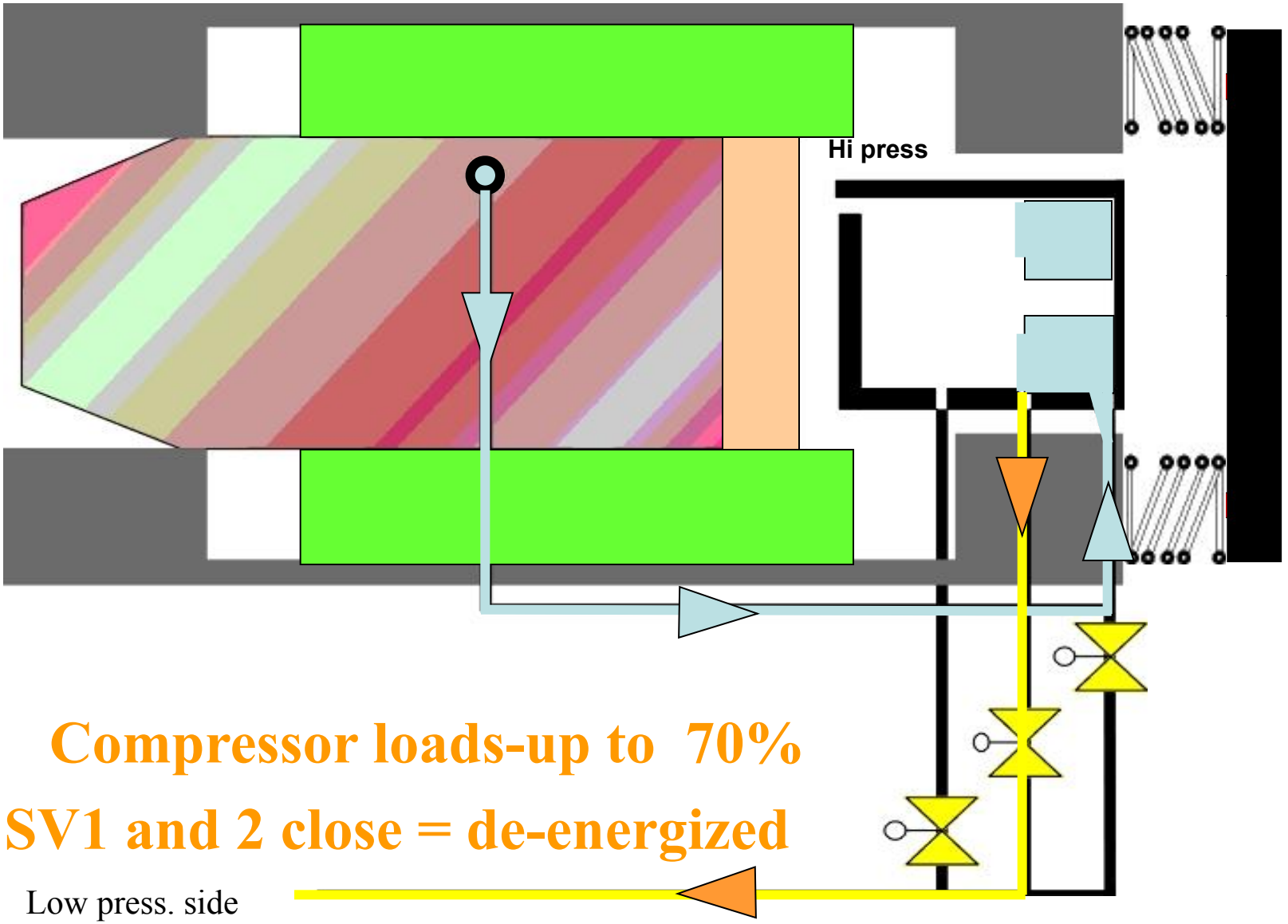


Compressor loads-up to 40%

SV1 closes = de-energized

Low press. side

*

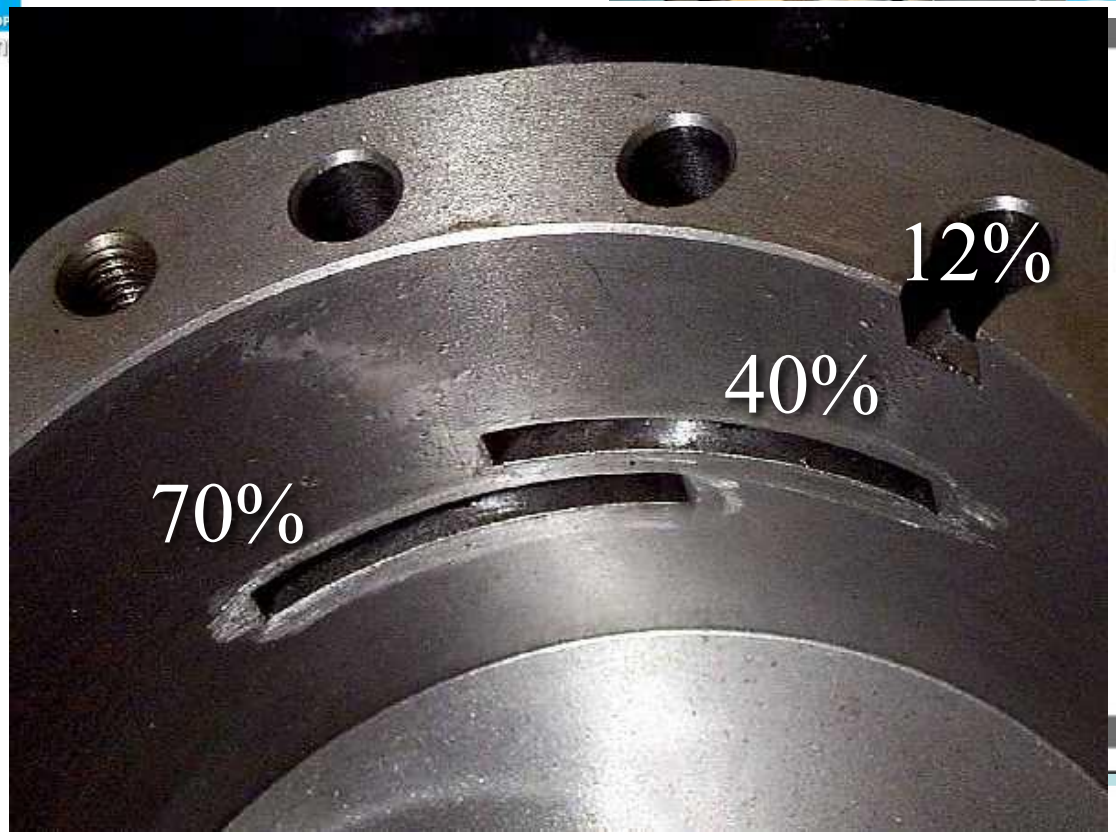


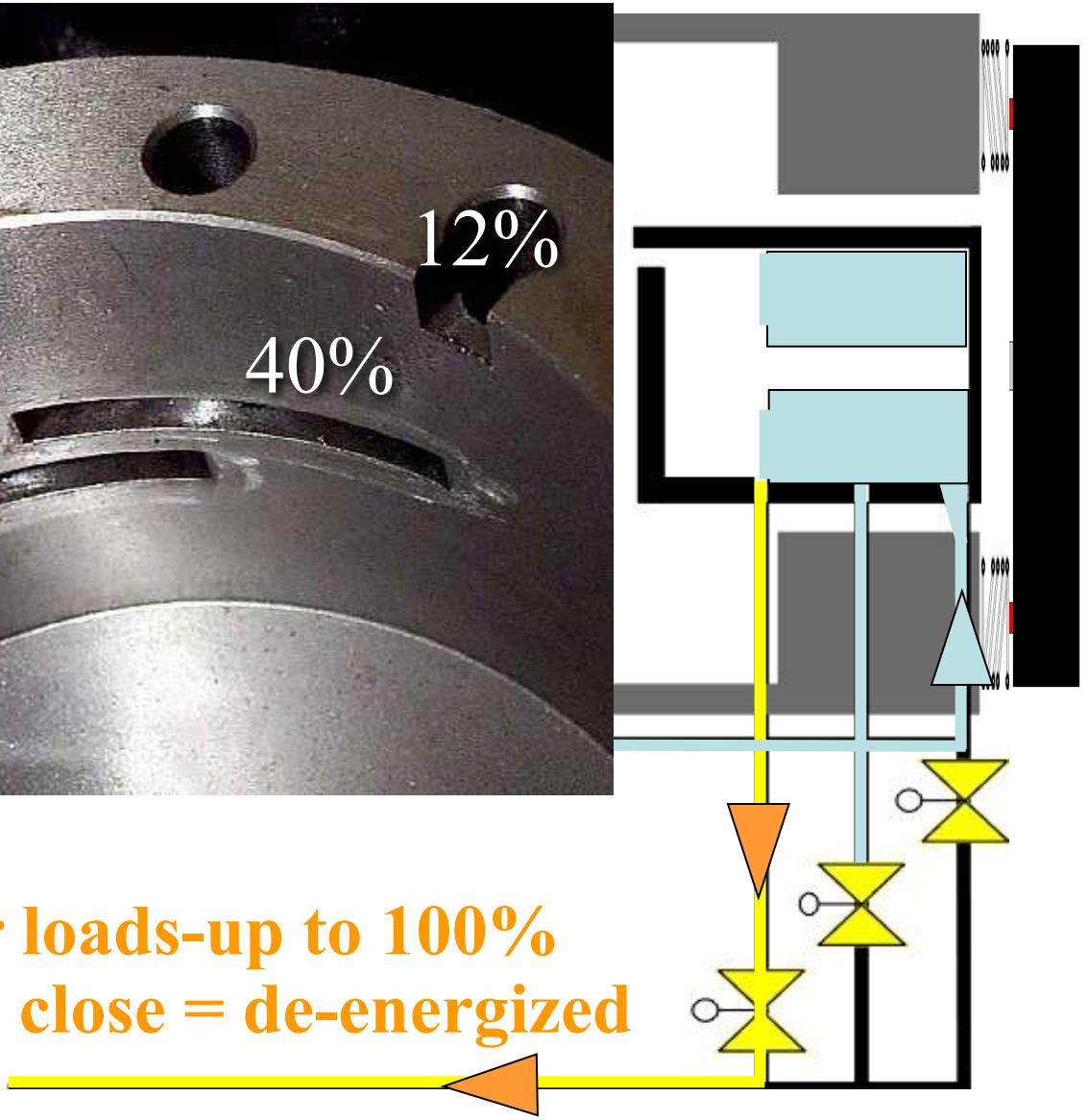
Compressor loads-up to 70%

SV1 and 2 close = de-energized

Low press. side

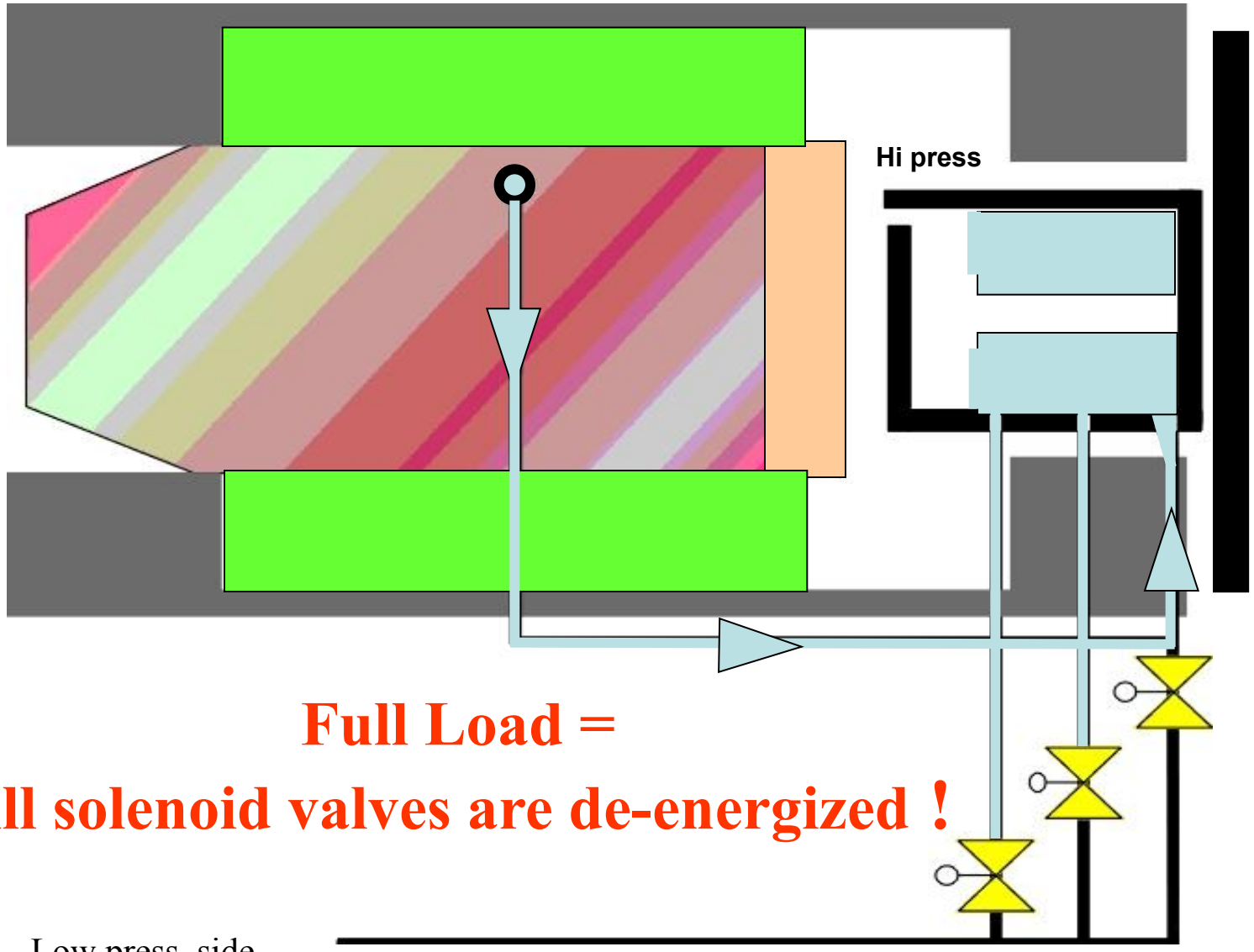
*





Compressor loads-up to 100%
SV1,2 and 3 close = de-energized

Low press. side



Full Load =

All solenoid valves are de-energized !

Low press. side

*

Capacity adjustment design stepLESS

Stepless control

Principle

Is based on internal pressure differences

Regulation of stepless capacity step with motor

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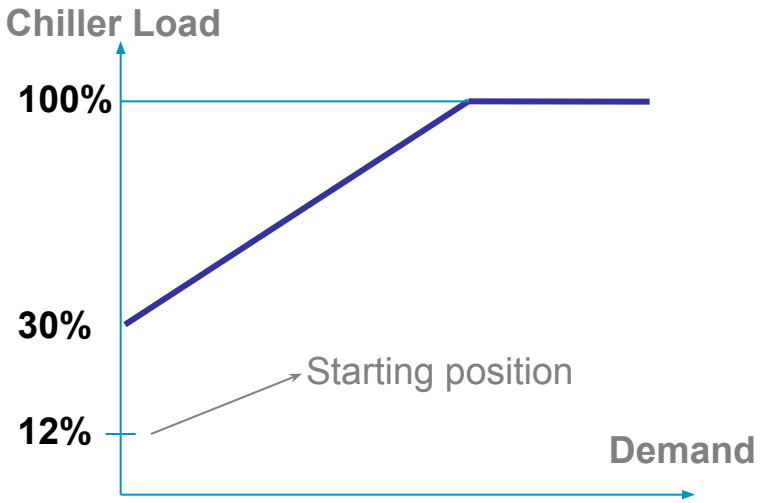
Stepless Single Screw Compressor

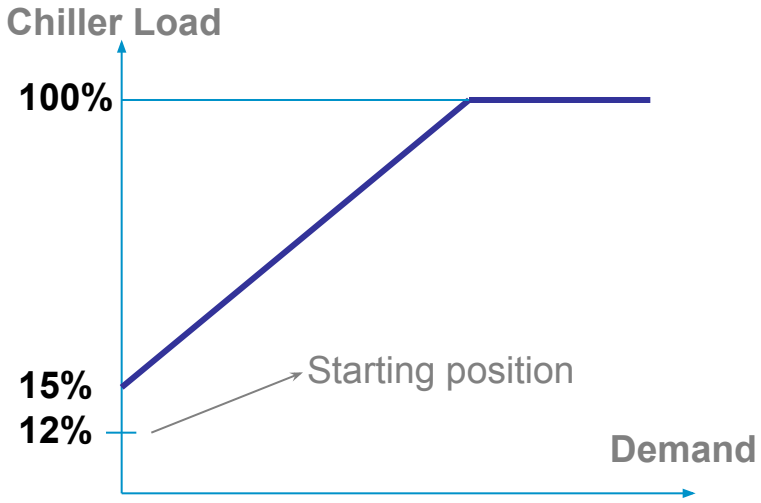
Higher Efficiency

STEPLESS capacity regulation

The compressor has built-in capacity control by 30 – 100%
by stepless slide valve mechanism, and adjustable volumetric ratio



Single Circuit



Double Circuit

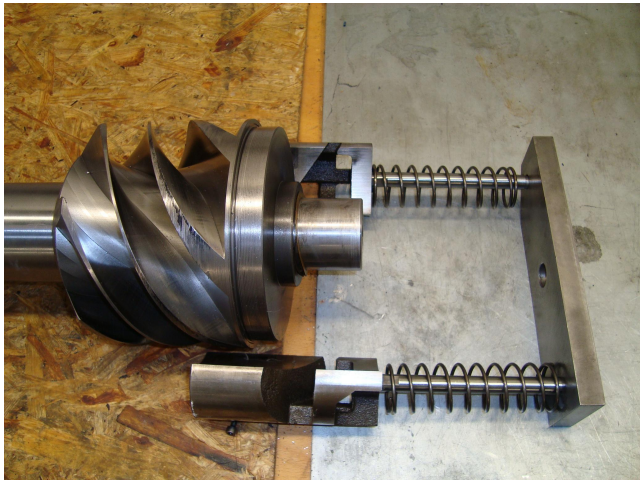
Designed, tested and manufactured in Daikin's own laboratories.

*

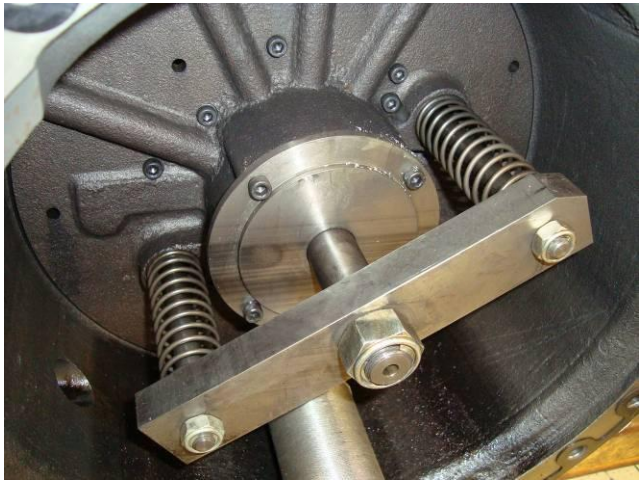
G type compressor with stepless control

stepless control/essential parts

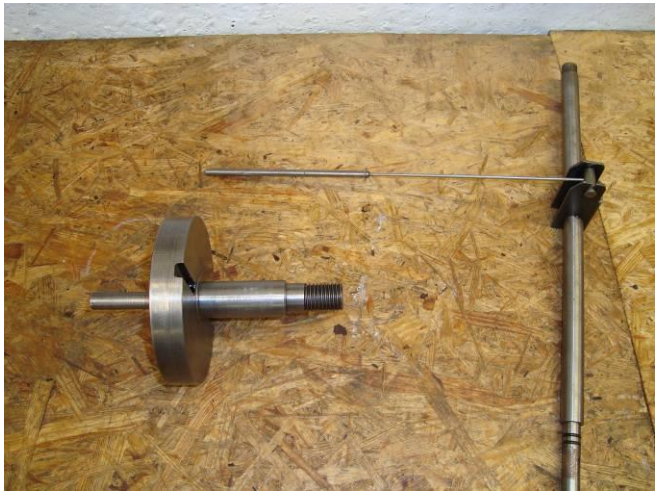
Slide vanes



Slide vanes with bridge



Pilot valve/ special piston



stepmotor

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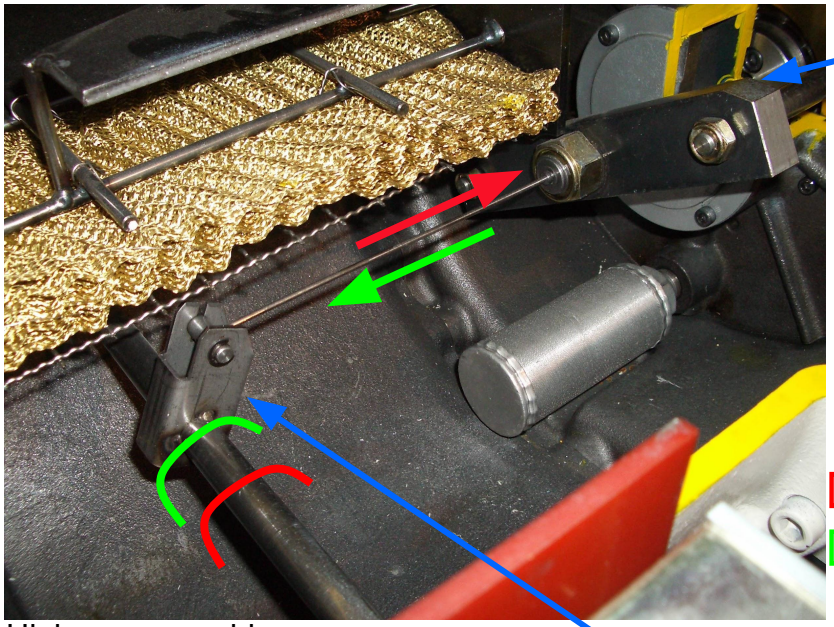
Stepless Single Screw Compressor

STEPLESS capacity regulation
How does it work ?



High pressure side

Pilot Valve + cylinder

Loading and unloading via Pilot Valve:

-Pilot valve is driven by rod mechanism

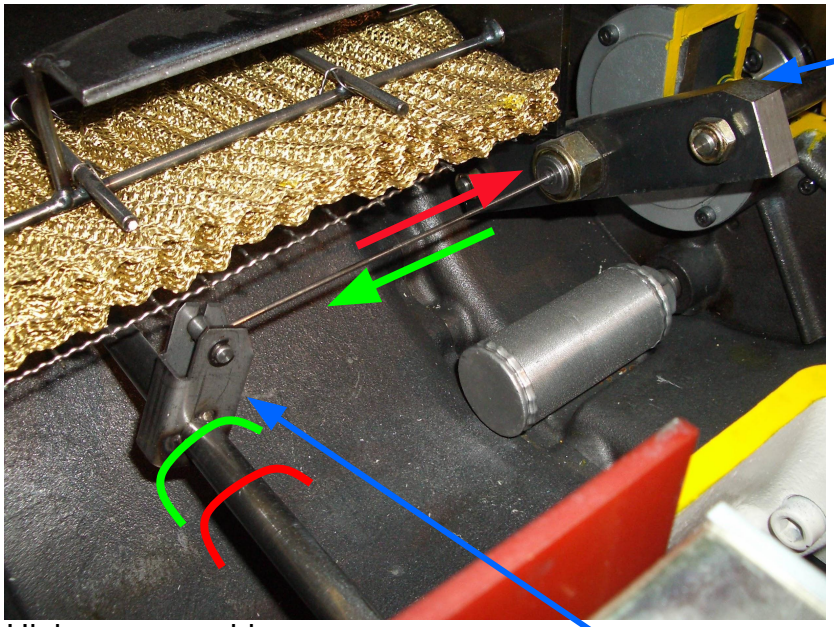
-The rod mechanism is driven by shaded-pole motor

Loading
Unloading

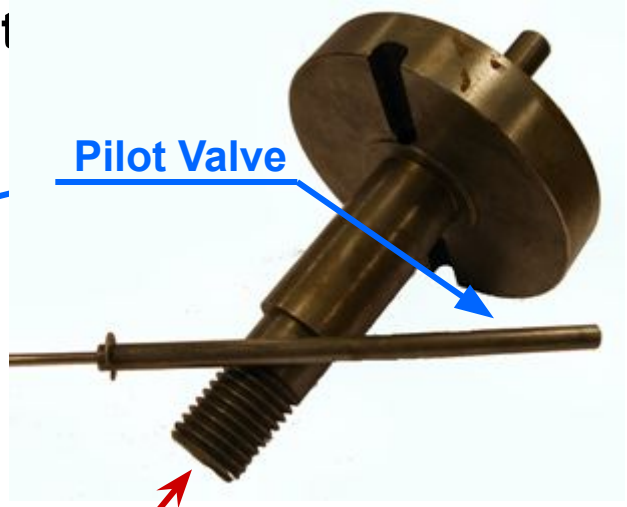
Rod mechanism

Stepless control

STEPLESS capacity regulation
How does it

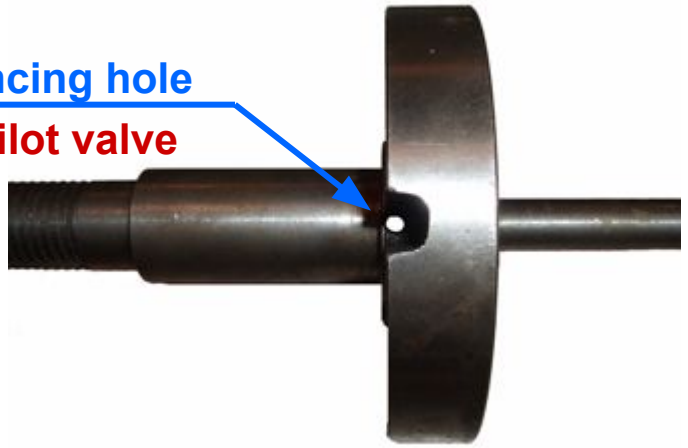


High pressure side



Bleedhole for pilot valve

Balancing hole

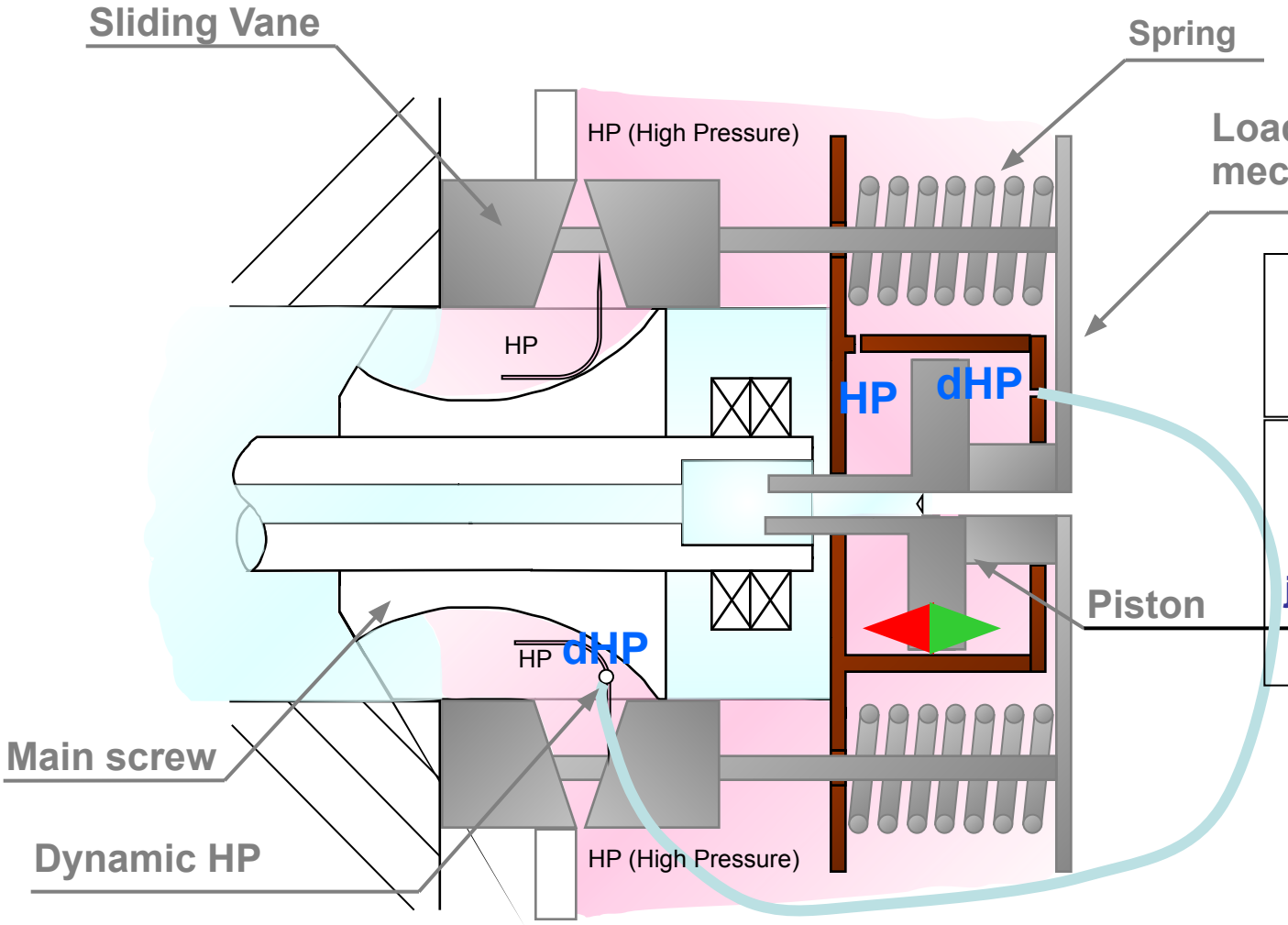


Rod mechanism

- Loading
- Unloading

*

Stepless regulation/pressure difference



HP = High pressure =

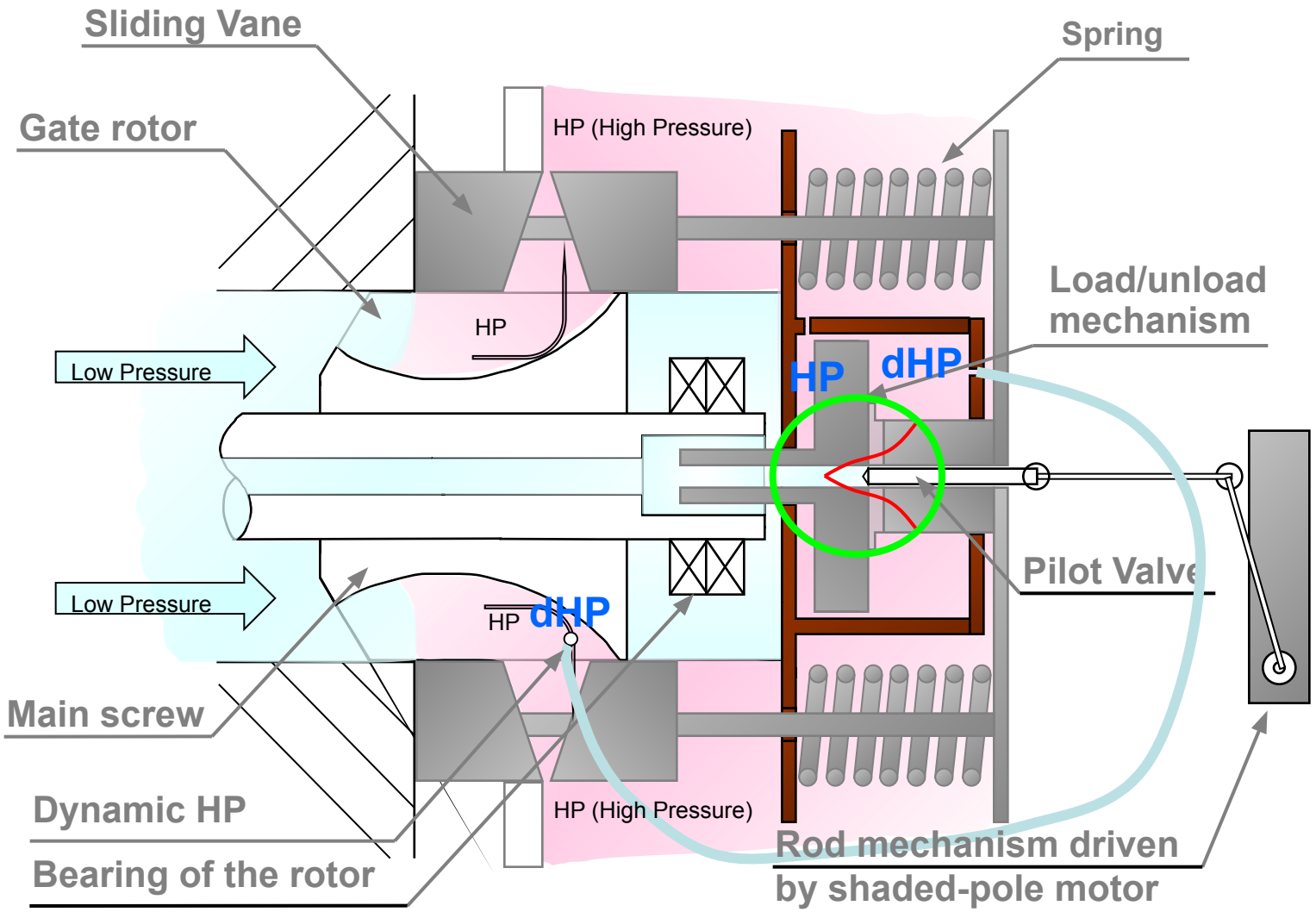
Pressure of refrigerant at discharge port

dHp = dynamic high pressure =

Pressure of refrigerant at just before discharge port =

dHp slightly > HP

Stepless Single Screw Compressor



@ 100%

Position of PILOT VALVE is not changed!

Small bleed

Towards LP-side

(Indicated by the green circle)

(ΔP = 2kg/cm²)

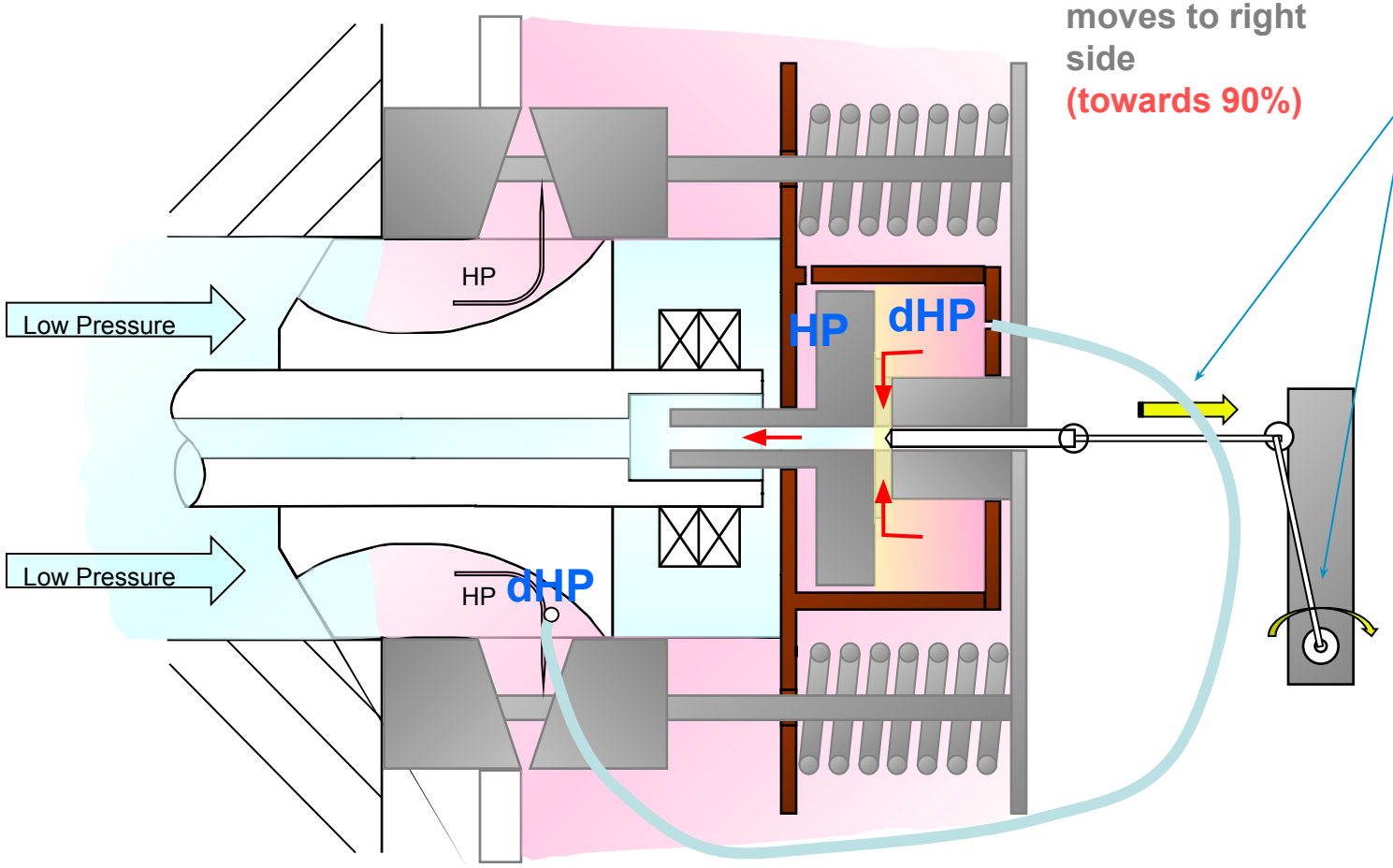
HP+ spring = dHP

SLIDING VANE stays @ position 100%

*

Stepless Single Screw Compressor

Unloading
from 100% to 90%



@ 100%

Position of PILOT VALVE moves right

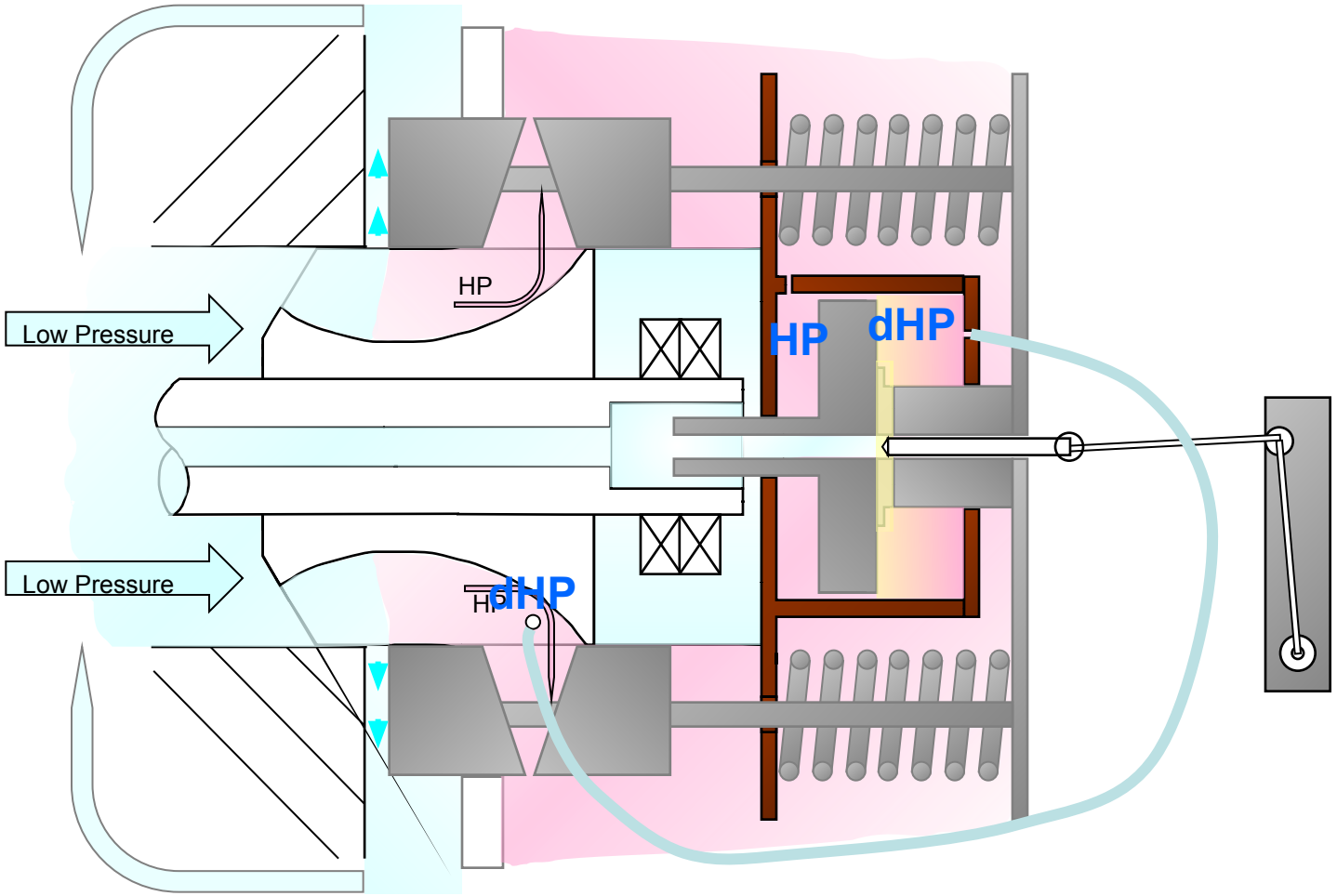
Bigger bleed

Towards LP-side

HP+spring > dHP

SLIDING VANE moves to right decrease CC

Stepless Single Screw Compressor



@ 95%

Position of PILOT VALVE moves right

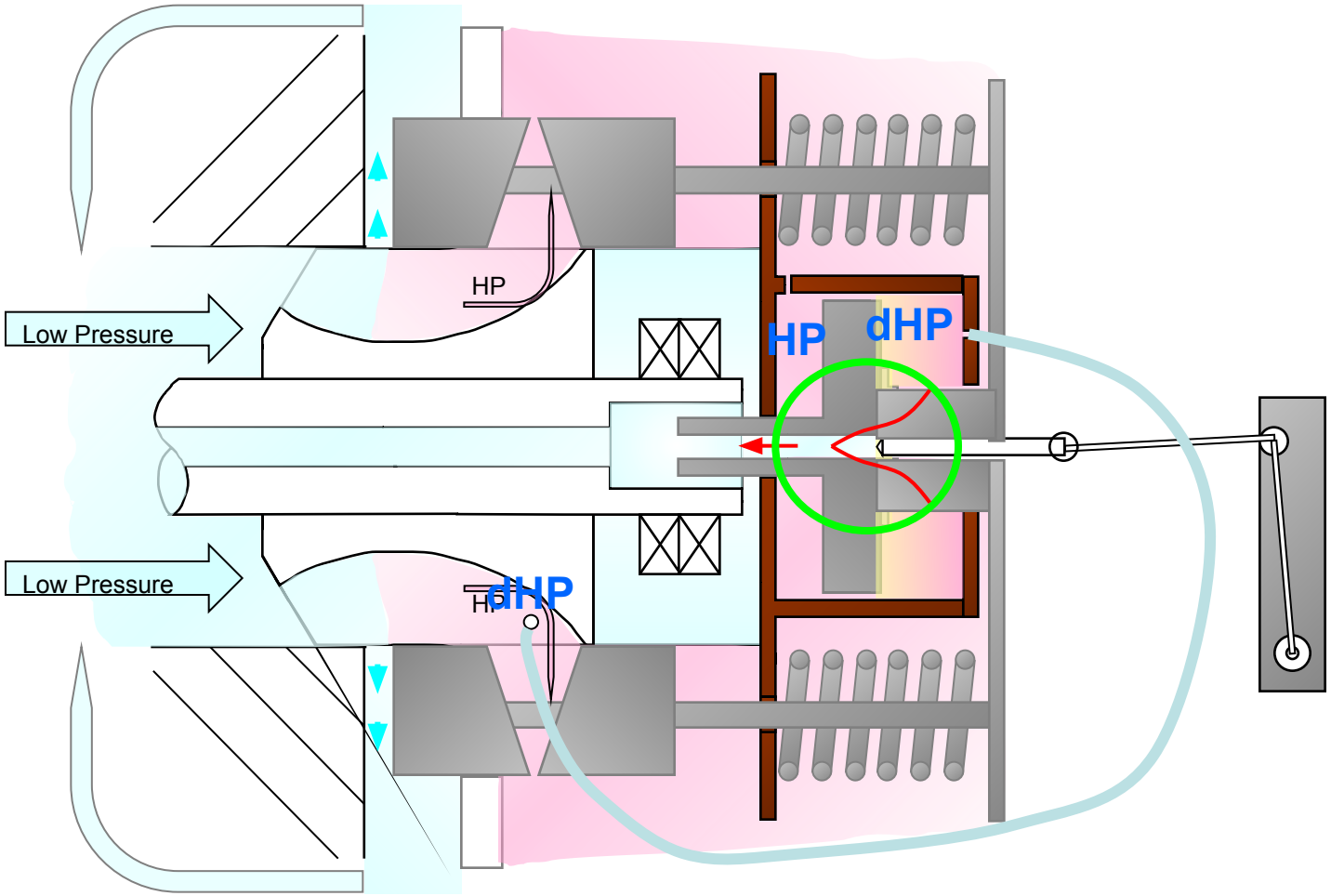
Bigger bleed

Towards LP-side

HP+spring > dHP

SLIDING VANE moves to right decrease CC

Stepless Single Screw Compressor



@ 90%

Position of PILOT VALVE is not changed!

Small bleed

Towards LP-side

(Indicated by the green circle)

(ΔP = 2kg/cm²)

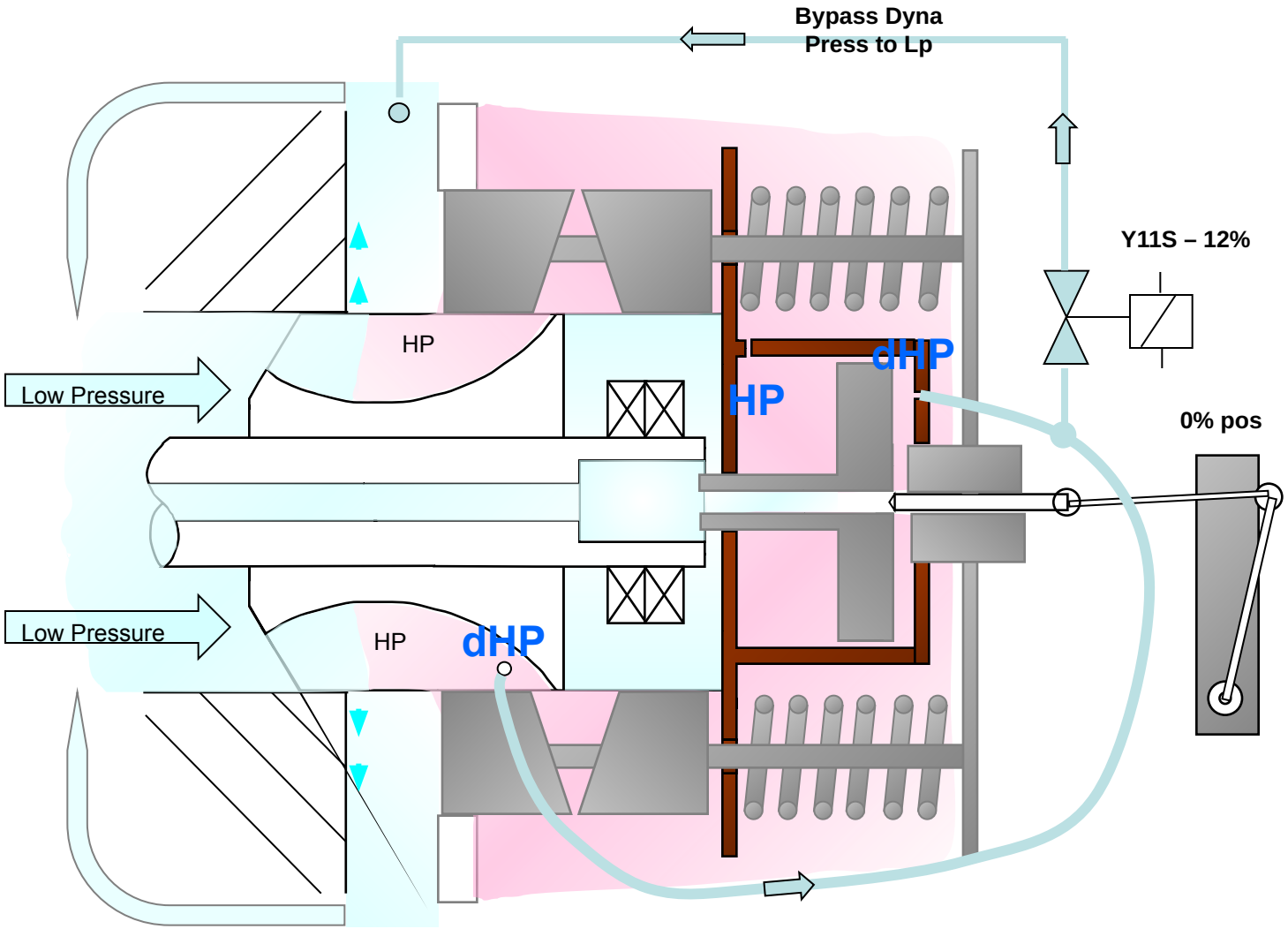
HP+spring = dHP

SLIDING VANE stays @ position 90%

*

Stepless Single Screw Compressor

Anim.



@ start

Position of PILOT VALVE Completely to the right!

bleed DP

Towards LP-side

Via 12% valve

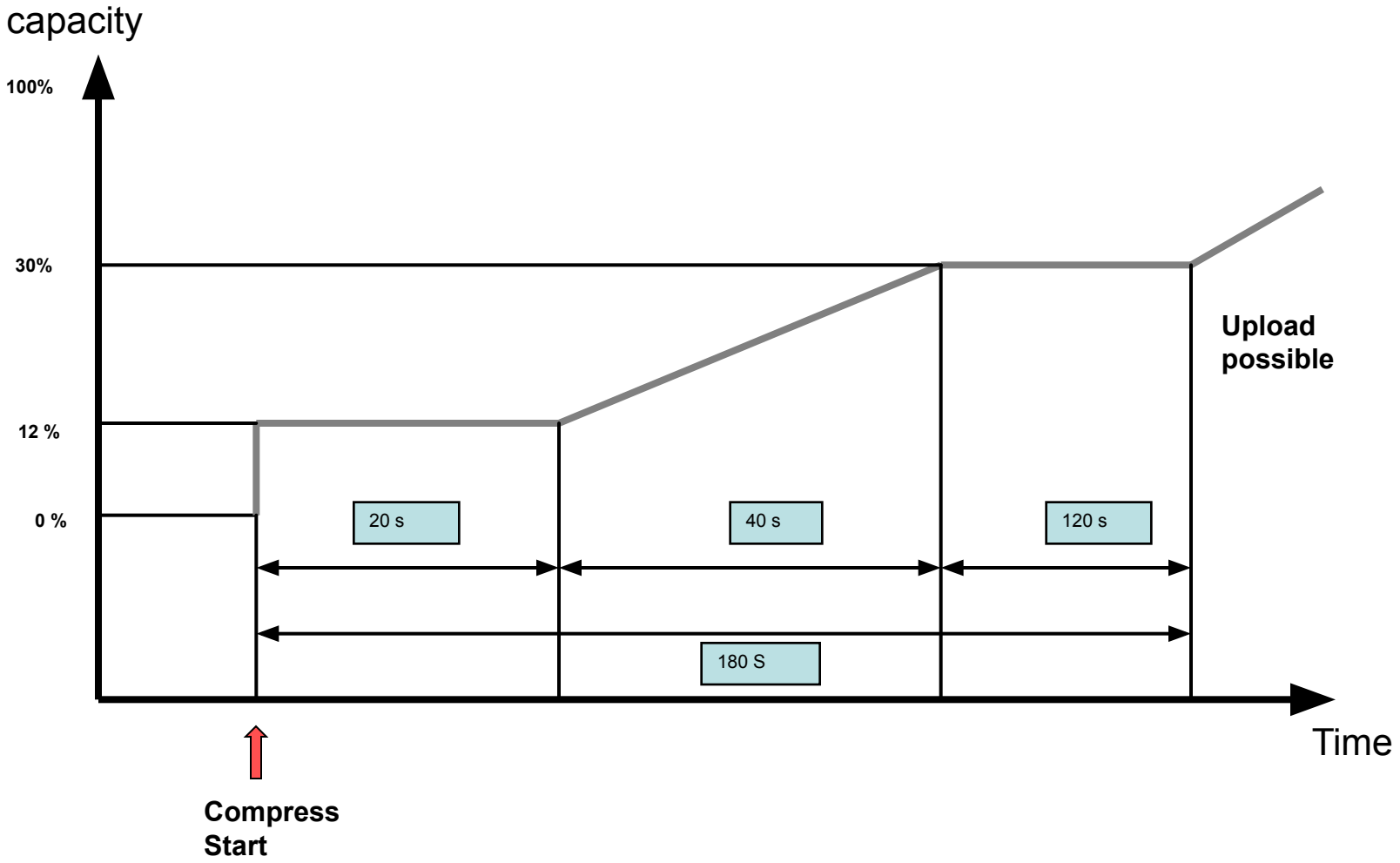
No further cap% build up possible

SLIDING VANE stays @ position 12%

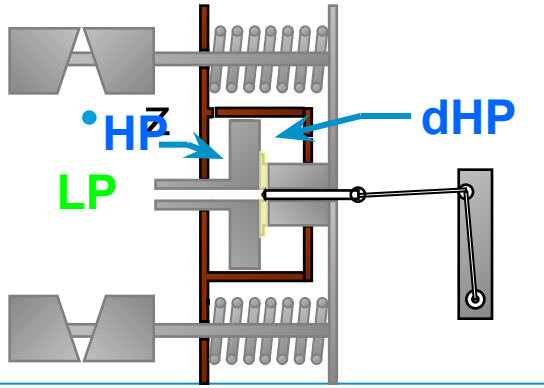
*

Stepless Single Screw Compressor

- Start up sequence



Stepless Single Screw Compressor



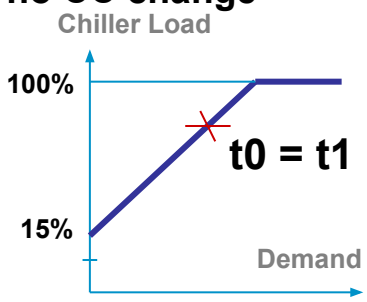
Position of PILOT VALVE Does not move

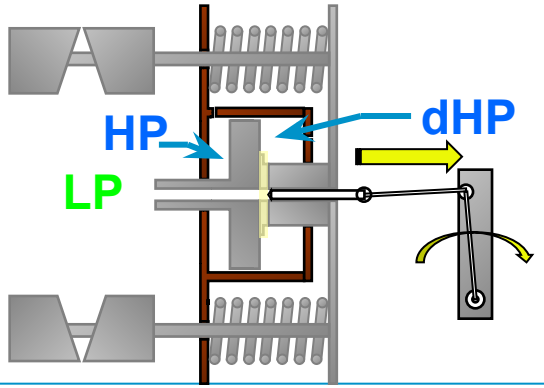
Small bleed

Towards LP-side

HP+spring = dHP

SLIDING VANE does not move no CC change





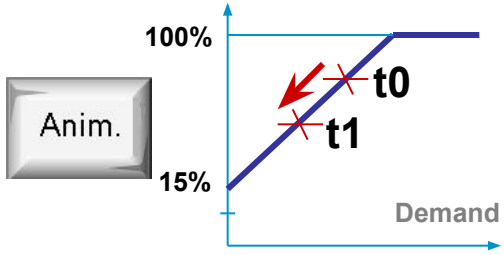
Position of PILOT VALVE moves RIGHT

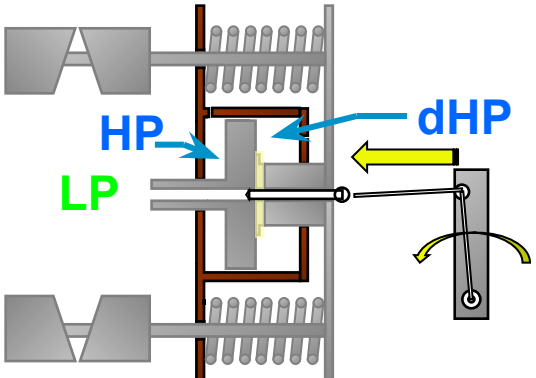
Bigger bleed

Towards LP-side

HP+spring > dHP

SLIDING VANE moves to right decreased CC





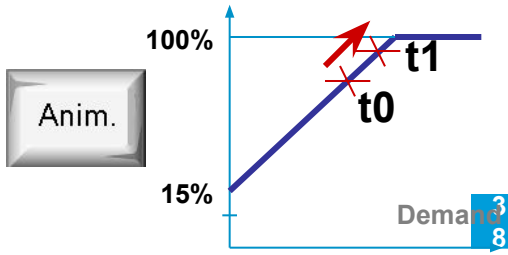
Position of PILOT VALVE moves LEFT

NO bleed

Towards LP-side

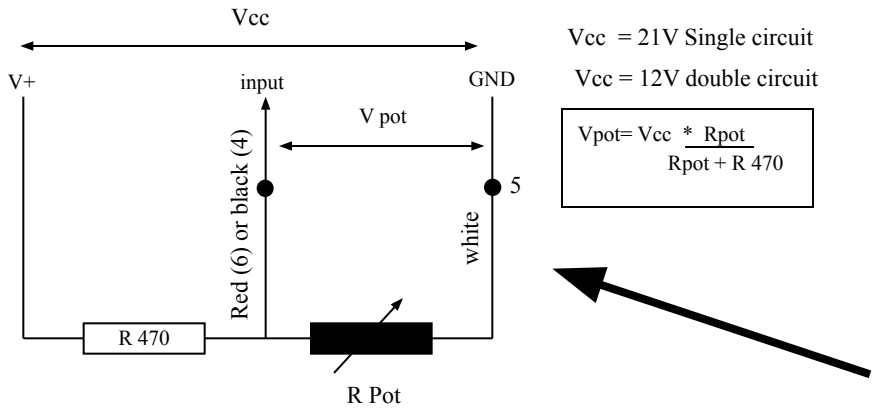
HP+spring < dHP

SLIDING VANE moves to left increased CC



Stepless Single Screw Compressor

- Step motor feedback principle

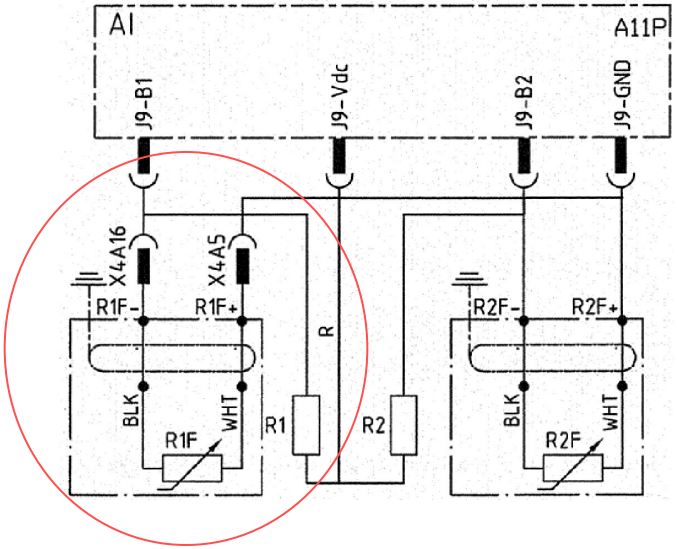


Vcc = 21V Single circuit

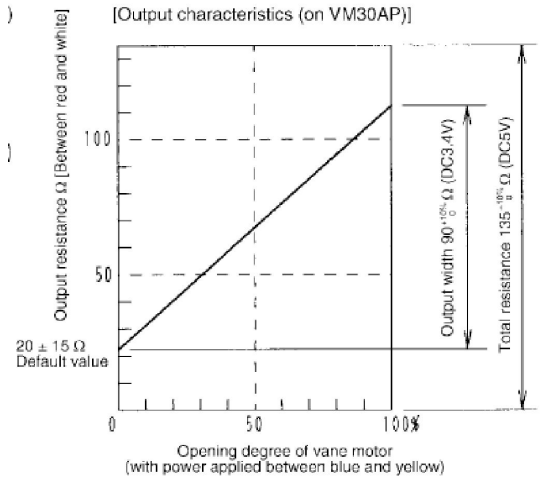
Vcc = 12V double circuit

$$Vpot = Vcc * \frac{Rpot}{Rpot + R\ 470}$$

Feedback from potentiometer (double circuit)

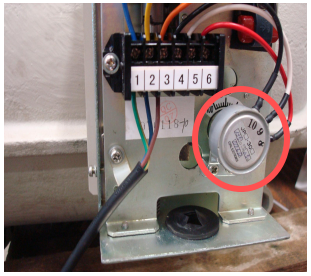


Potentiometer Output



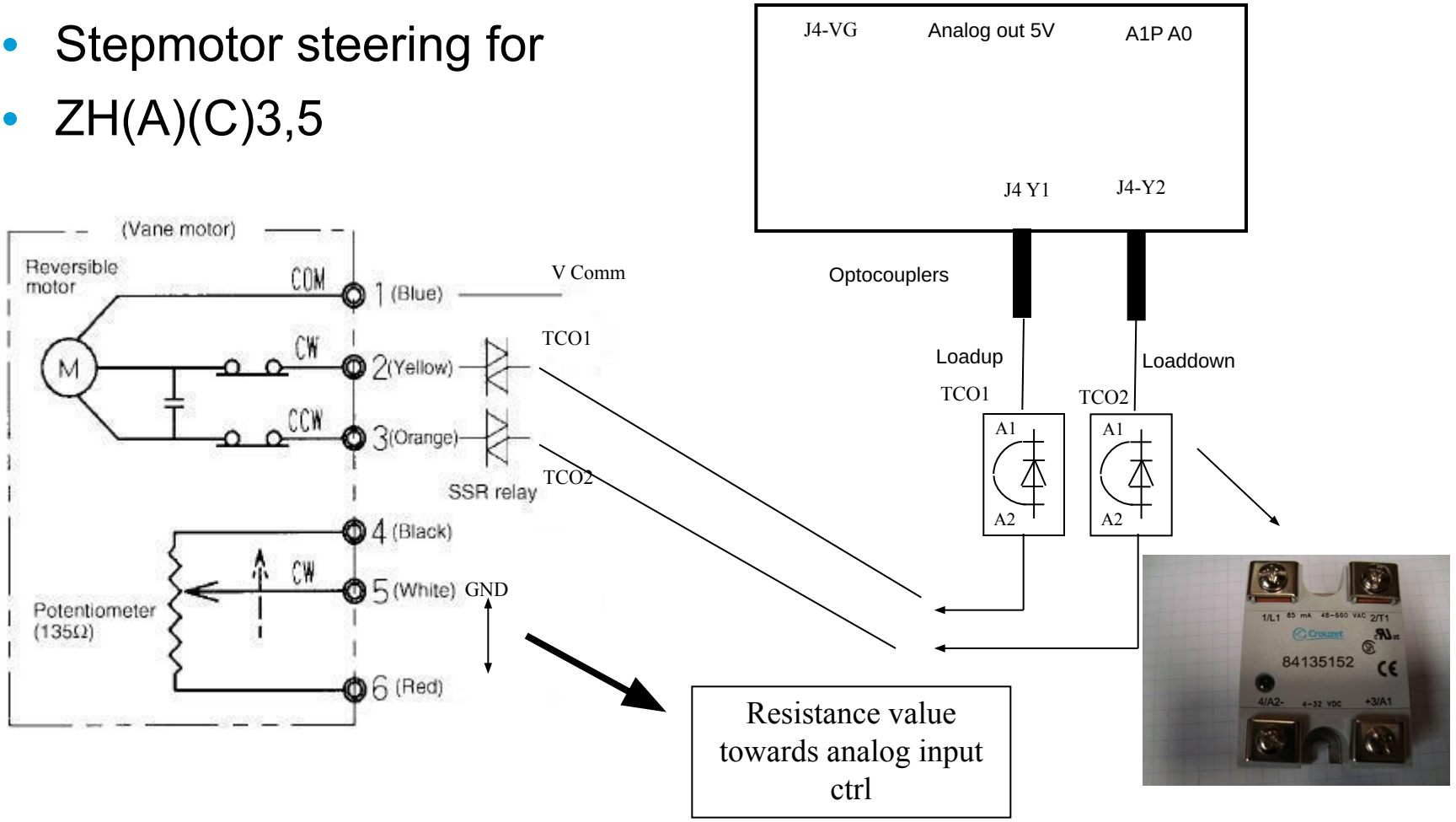
@ 100% R=+/- 125 Ohm

@ 30% R=+/- 35 Ohm



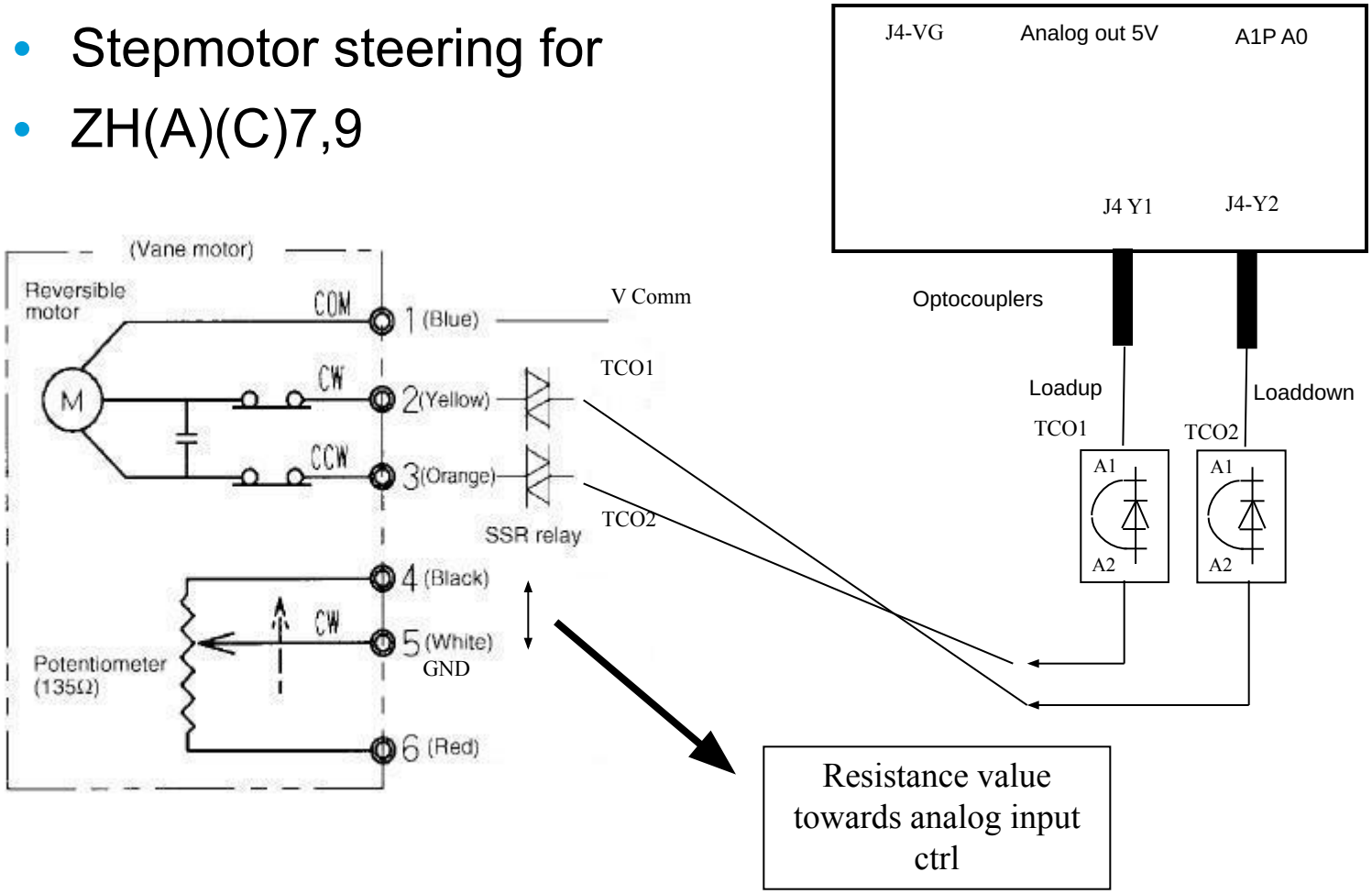
Stepless Single Screw Compressor

- Stepmotor steering for
- ZH(A)(C)3,5



Stepless Single Screw Compressor

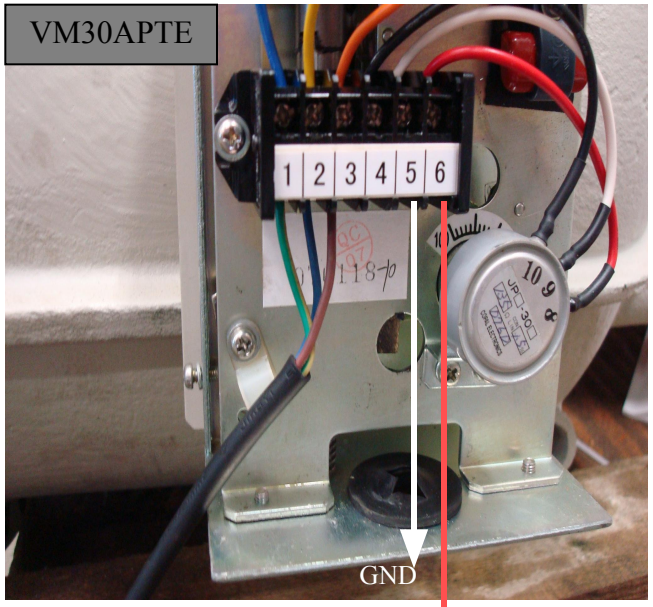
- Stepmotor steering for
- ZH(A)(C)7,9



Stepless Single Screw Compressor

- **Stepmotorconnections**

ZH.. 3& 5 types

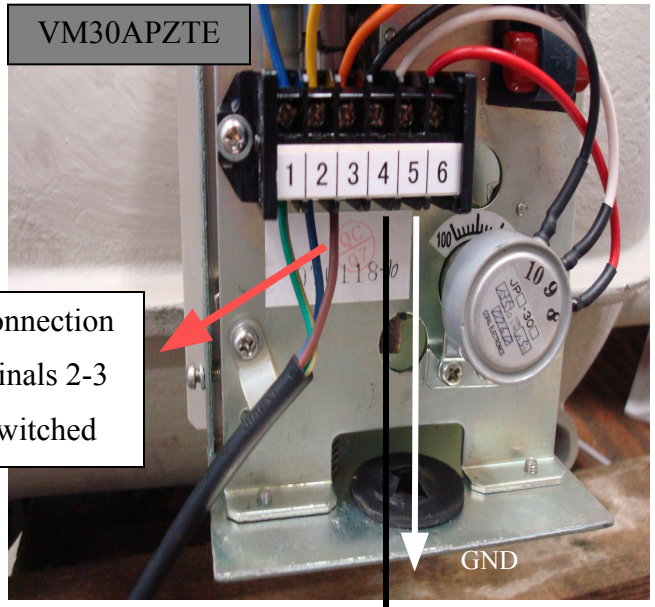


230V from SSR's

Towards anaog input controller

Motor connection
On terminals 2-3
To be switched

ZH.. 7&9 types



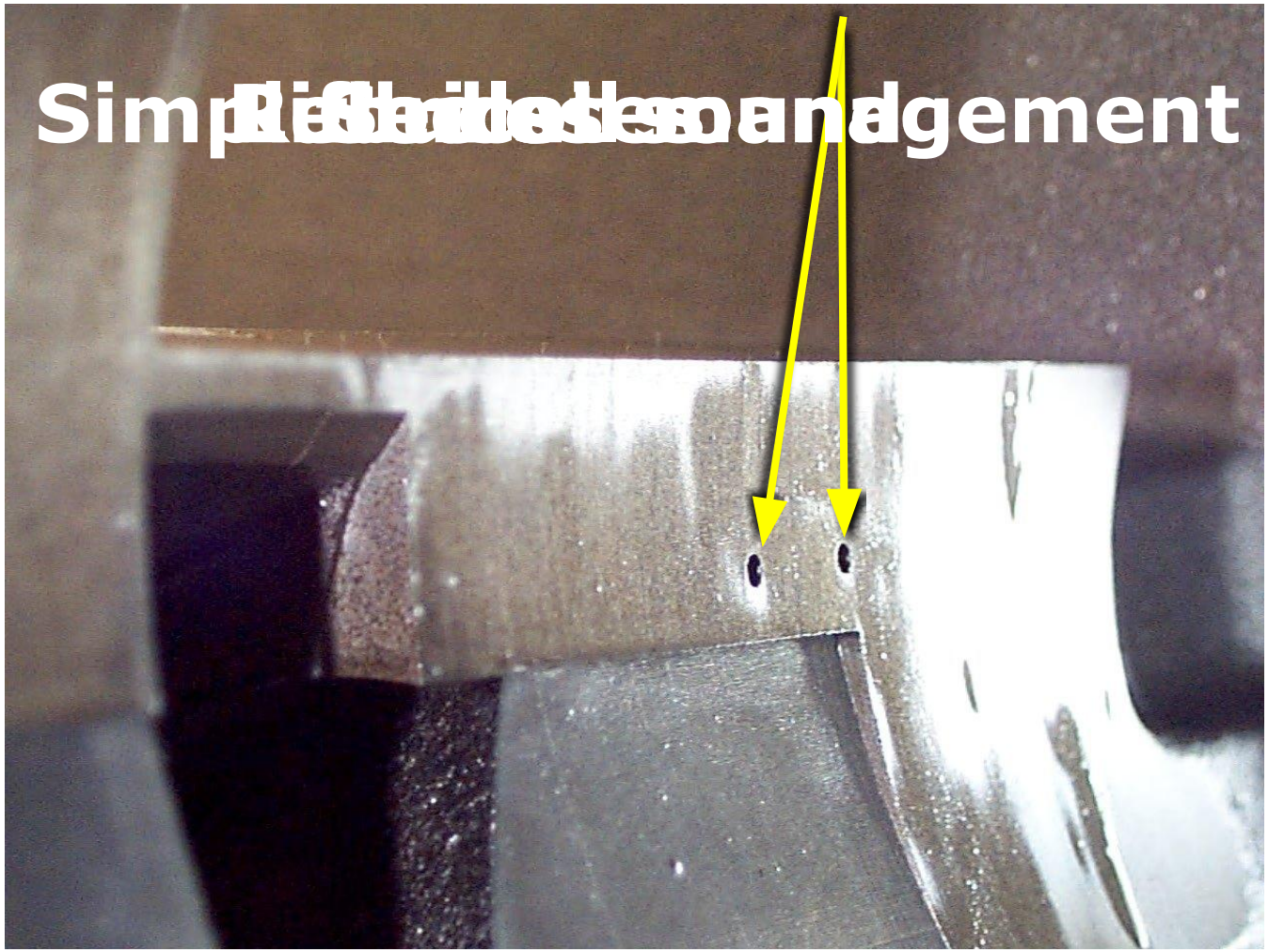
230V from SSR's

Towards analog input controller

*

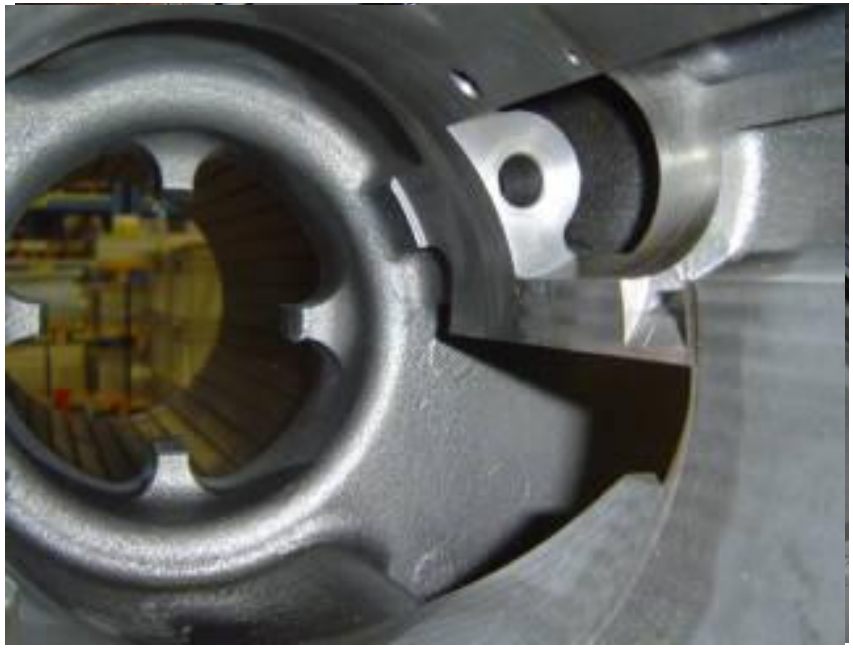
Single screw compressor

Oil and Liquid injection design



Single screw compressor

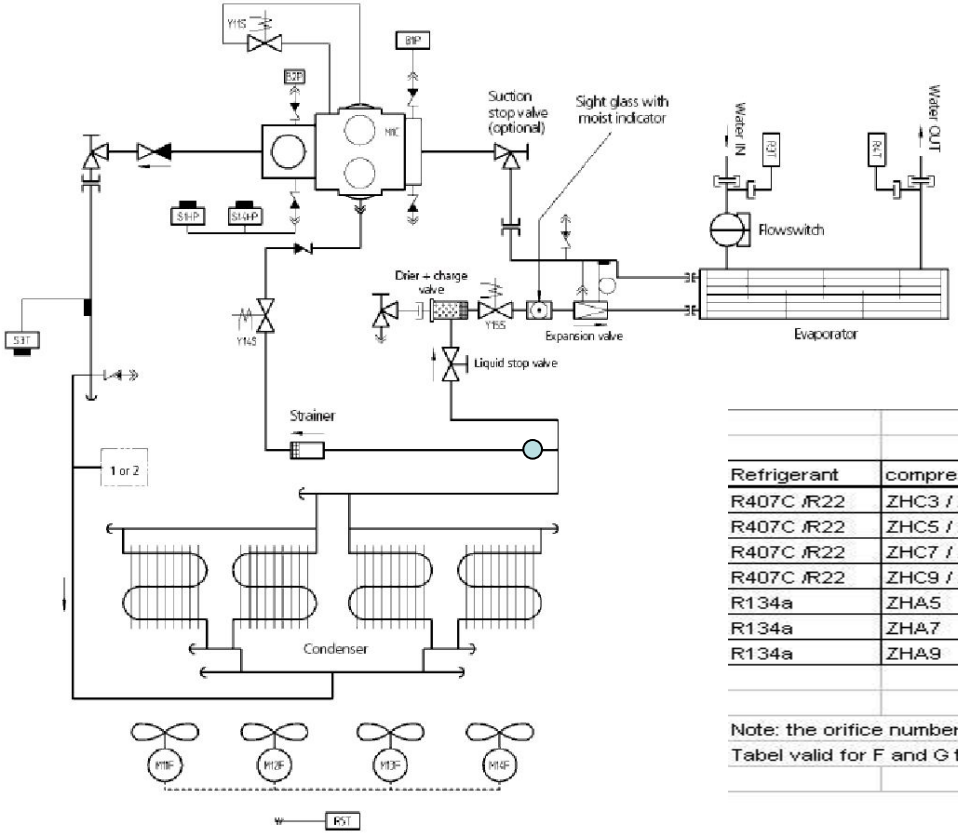
- Liquid injection point (fixed oriffice) ⟹ Cool Main screw



- Never shut off, during operation compressor
- For pumpdown use integrated pump down function of controller

Single screw compressor

- Liquid injection piping (example for EWAD MBY)



Orifice opening according to compressor type				
Refrigerant	compressor type	orifice diam,	orifice number	partnumbers
R407C /R22	ZHC3 / ZH3	1,9	2	903039
R407C /R22	ZHC5 / ZH5	2,2	1	824686
R407C /R22	ZHC7 / ZH7	2,6	3	1013504
R407C /R22	ZHC9 / ZH9	4,2	4	1013410
R134a	ZHA5	1,4	6	1013218
R134a	ZHA7	1,7	5	1013528
R134a	ZHA9	1,9	2	903039

Note: the orifice number is mentioned on one of the sides of the hexagon socket pipe plug
Tabel valid for F and G type compressors

Single screw compressor

Periodic Inspection

*

Single screw compressor - Inspection

Periodic Inspection - Check points

- ✔ Insulation Resistance of the Motor.
- ✔ Inspection/Changement of the Refrigerant Oil.
- ✔ Inspection the Gate Rotor.
- ✔ Cleaning the Suction filter.

*

Single screw compressor - Inspection

Check points

✔ Insulation Resistance of the Motor.

After 1year of operation.
Use a 500-V megger.
Loose all the wires.
Measure between the phases
Measure between the CTP and phases
Measure between earth, CTP and phases
Value >= 3MΩ

Single screw compressor - Inspection

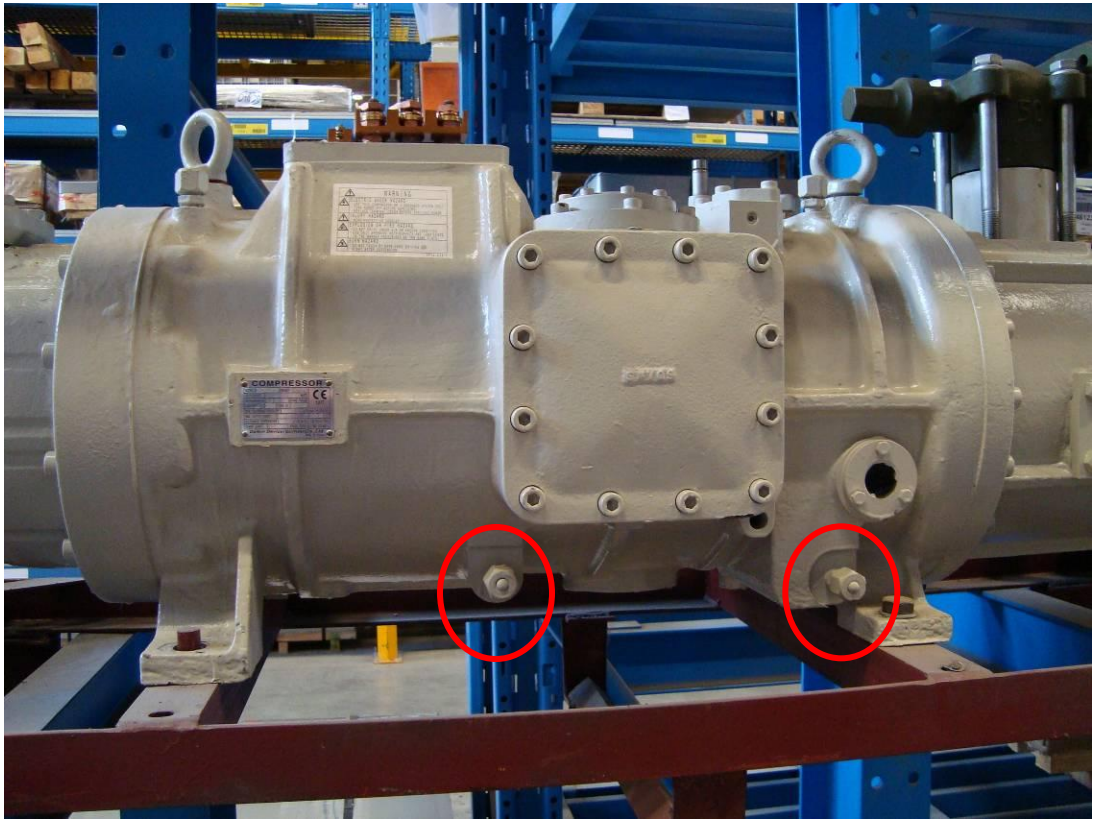
Check points

- ✔ Inspection/Changement of the Refrigerant Oil.
  - Take a oil sample on one of the two oil drain ports.
  - Check oil (color, acid test, moisture, …)
  - Reduce the pressure (pump down).
  - Recover the internal rest pressure.
  - Take a oil sample on one of the two oil drain ports.
  - Check oil (color, acid test, moisture, …)
  - After 7500 hr or 4 years operation. Adviced to change oil

*

Single screw compressor - Inspection

- Oil drain ports



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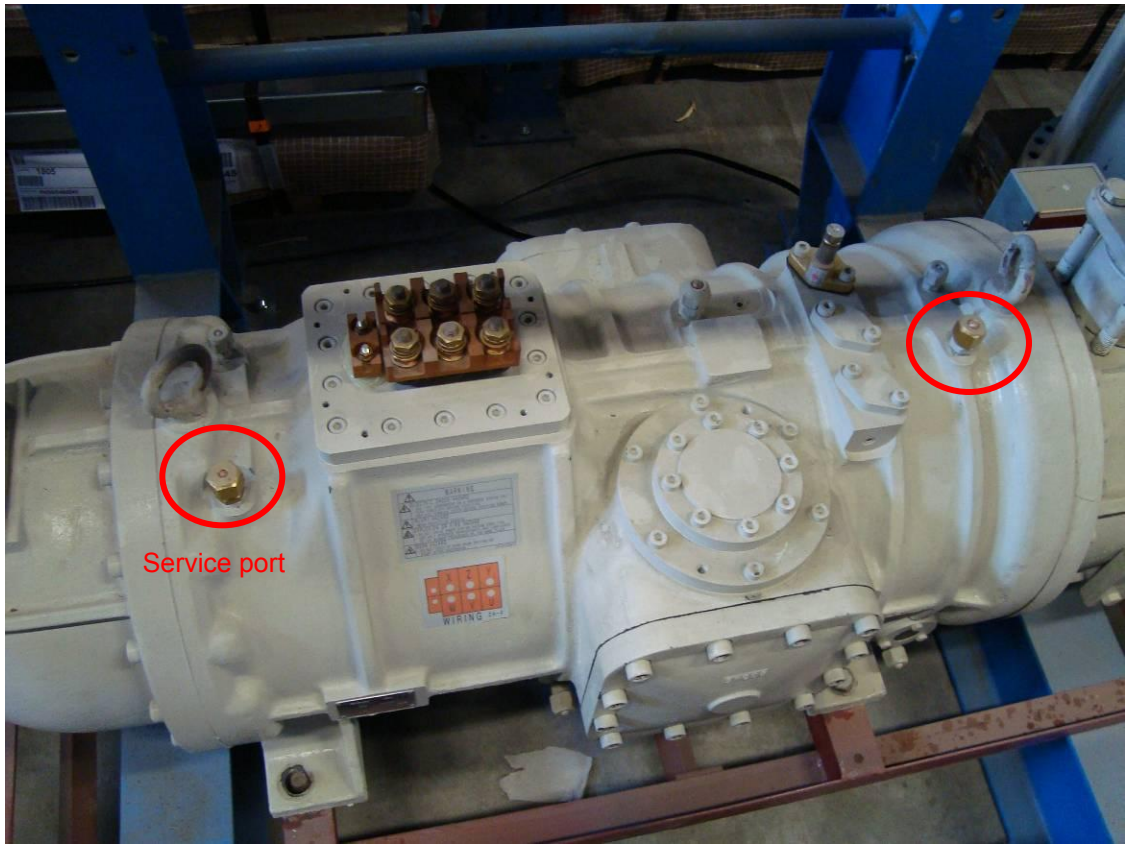
Single screw compressor - Inspection

- Oil charging port & service port (vacuum pump)



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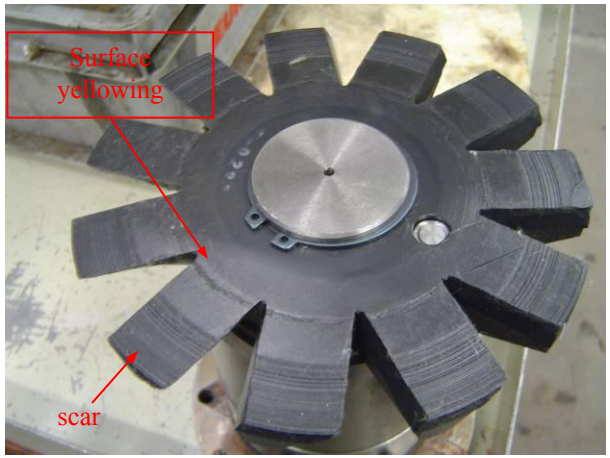
Single screw compressor - Inspection

Check points



✔ Inspection the Gate Rotor

After 20000 hr or 4 years operation.
Reduce the pressure (pump down).
Recover the internal rest pressure.
Remove the side covers.
Inspection of the gate rotor.

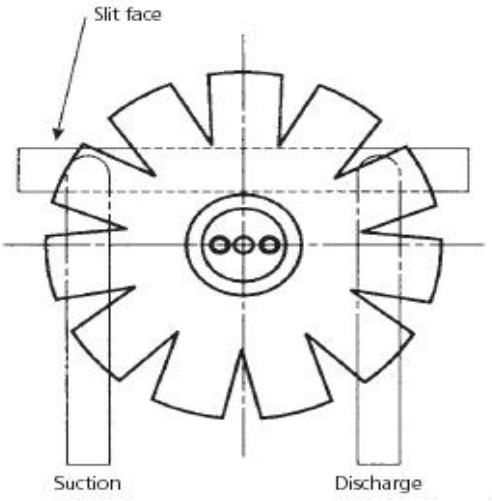
Item	Standard	Remedy
Cracking	No cracking	Replace
Chipping	No chipping 3 mm or more in long side	
Scar	No scar 1 mm or deeper	
Surface scratching		

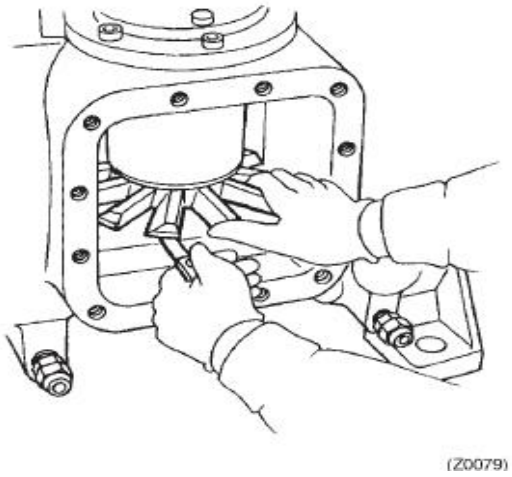
Single screw compressor - Inspection

Check points

- ✔ Inspection the Gate Rotor

Measuring the slit clearance (60 to 90 µm).



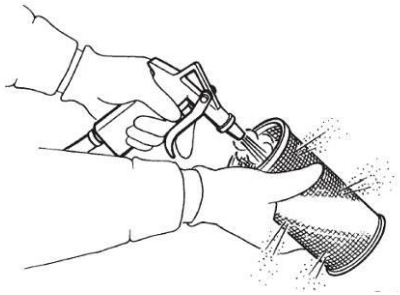


Single screw compressor - Inspection

Check points

✔ Cleaning the Suction Filter

After 20000 hr or 4 years operation.
Reduce the pressure (pump down).
Recover the internal rest pressure.
Disconnect the suction pipe.
Clean the suction filter with compressed air.



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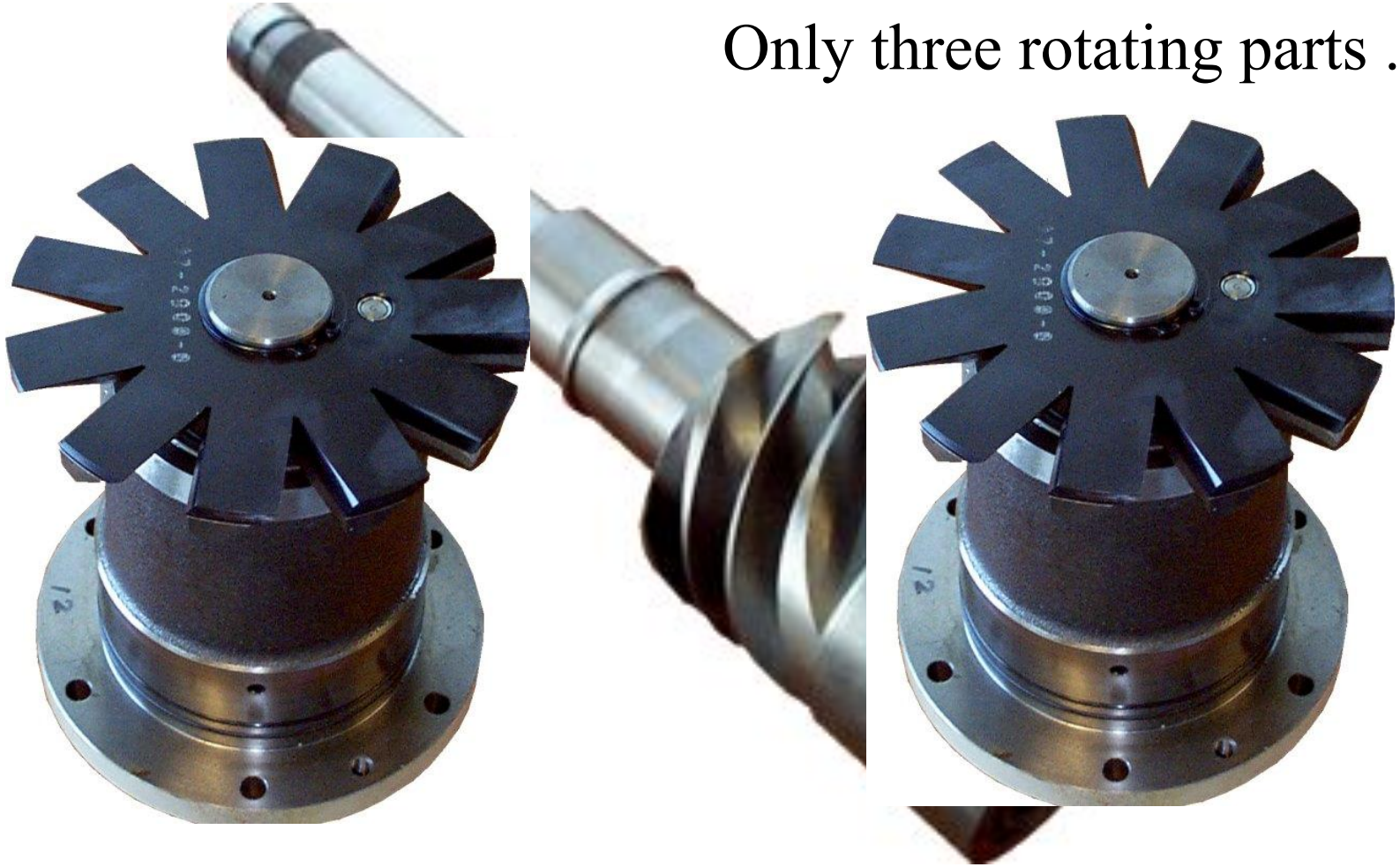
Single screw compressor

Overhaul

Low Maintenance Costs

Only three rotating parts ...



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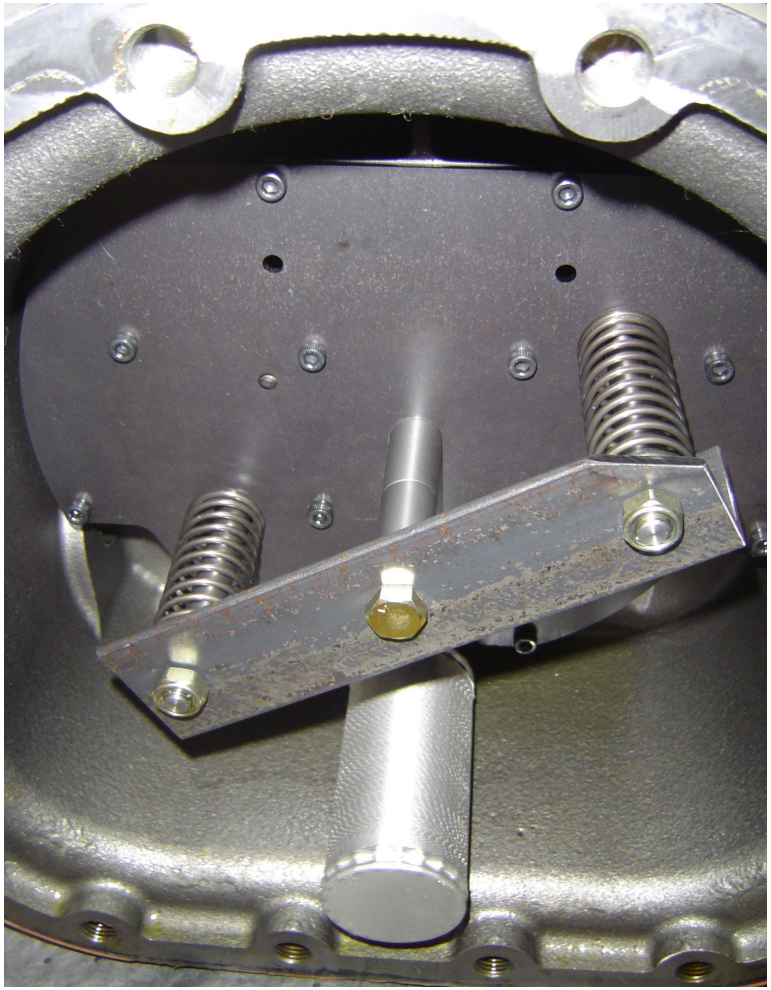
Low Maintenance Costs



NO O-rings
NO gaskets

↓

Sealing via oilpressure

NO Oilpump

↓

Oilcirculation due to differntial pressure

*

Single Screw Compressor - Overhaul

Overhaul (see service manual Si50-402A)

- Overhaul interval:40.000 hrs or 7 years, wichever comes first
  - Change of oil
  - Change of gate rotors if needed + O-rings
  - Change of all gaskets and O-rings
  - Change of all bearings (mainscrew and gaterotor bearings
    - Complete dismanteling of compressor needed

*

Single Screw Compressor - Overhaul

Overhaul Instructions Chart (See Service Manual SiE50-402A)

1. Disassembly and Inspection

- ✔ Drain The Oil
- ✔ Remove Side Covers
- ✔ Inspection of The Gate Rotors and Surrounding Parts
- ✔ Dissamble The Gate Rotor and Surrounding Parts
- ✔ Remove and Install The Gate Rotor
- ✔ Remove The Suction End Cover
- ✔ Remove The Motor Rotor
- ✔ Disassemble The Loading/Unloading Mechanism
- ✔ Remove and Disassemble The Screw Assembly Pulley

*

Single Screw Compressor - Overhaul

Overhaul Instructions Chart (See Service Manual SiE50-402A)

2. Replacing The Bearing

- ✔ Remove The Bearings
  - Suction end cover bearing (Outer ring)
  - Screw shaft bearing (Inner ring)
  - Main bearing (matched pair)
  - Gate rotor bearings (4)
- ✔ Install The Bearings

*

Single Screw Compressor - Overhaul

Overhaul Instructions Chart (See Service Manual SiE50-402A)

3. Final Assembly

- ✔ Assemble The Screw Shaft and Main Bearing Holder
- ✔ Insert The Screw Shaft
- ✔ Install The Motor Rotor
- ✔ Install The Suction End Cover
- ✔ Verify The Position of The Screw Rotor
- ✔ Install The Gate Rotor and Adjust The Slit Clearance
- ✔ Install The Main Bearing Holder Fixing Plate, Assemble The Loading/Unloading Mechanism and Instal The Oil Filter
- ✔ Install The Discharge End Cover

*

Single Screw Compressor - Overhaul

Overhaul Instructions Chart (See Service Manual SiE50-402a)

4. Airtightness Test

- ✔ Using dry air mixed with refrigerant, or Nitrogen, pressurize to A

refrigerant type	A
R22	2.8MPa (28bar)
R134a	2.0MPa (20bar)
R407c	2.98MPa (29.8bar)

*

Single Screw Compressor - Overhaul

Overhaul Instructions Chart (See Service Manual SiE50-402a)

5. Charging Oil

- ✔ Charge the same quantity of oil removed during disassembly
- ✔ Devide the quantity over the suction and discharge side

*

Single Screw Compressor - Overhaul

Overhaul Instructions Chart (See Service Manual SiE50-402a)

6. Caution in Test Operation

- ✔ Check the tightness of all bolts
- ✔ Check wiring connection
- ✔ Check pressures
- ✔ Check noise and vibrations

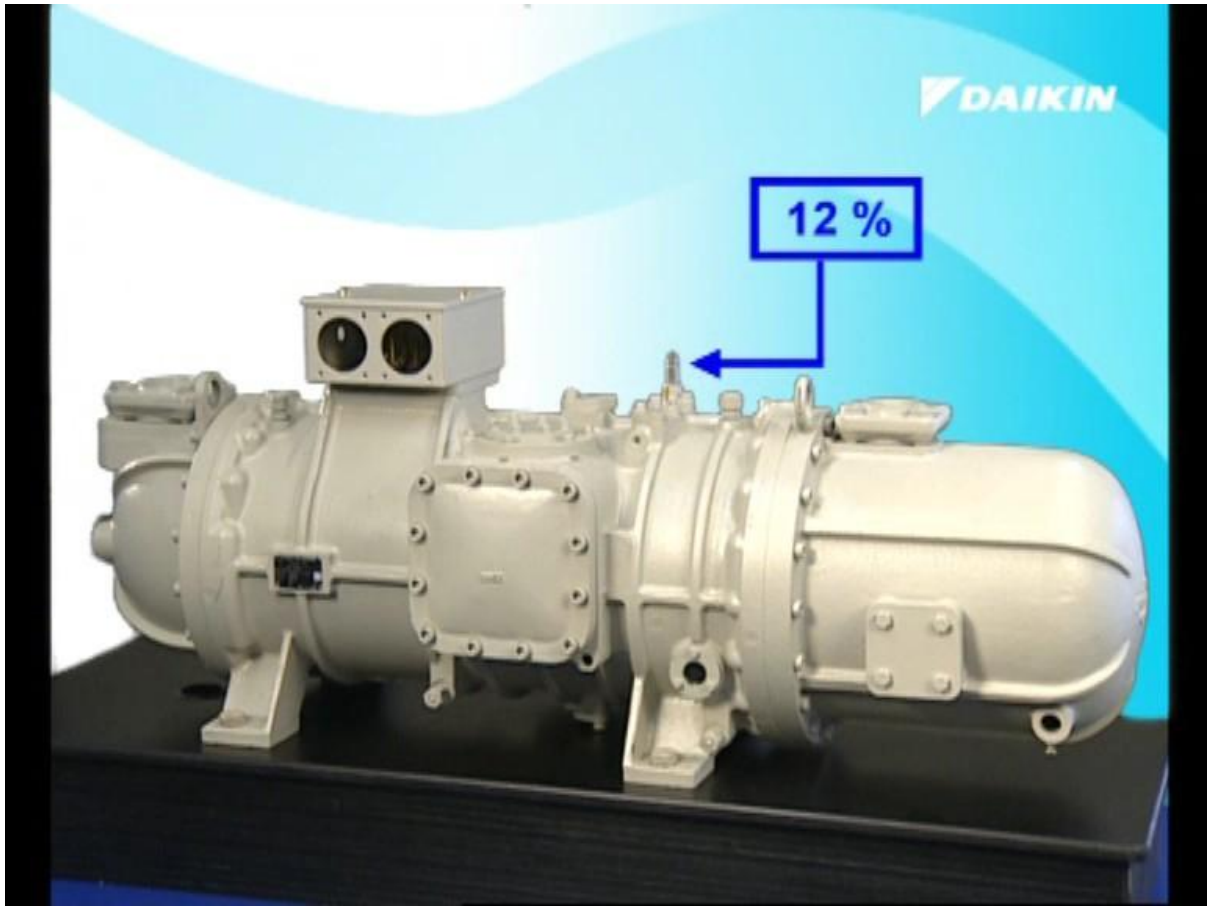
*

Single Screw Compressor – Overhaul pics

*

Stepless Single Screw Compressor

- 12 % solenoid valve



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