Westfalia Separator AG

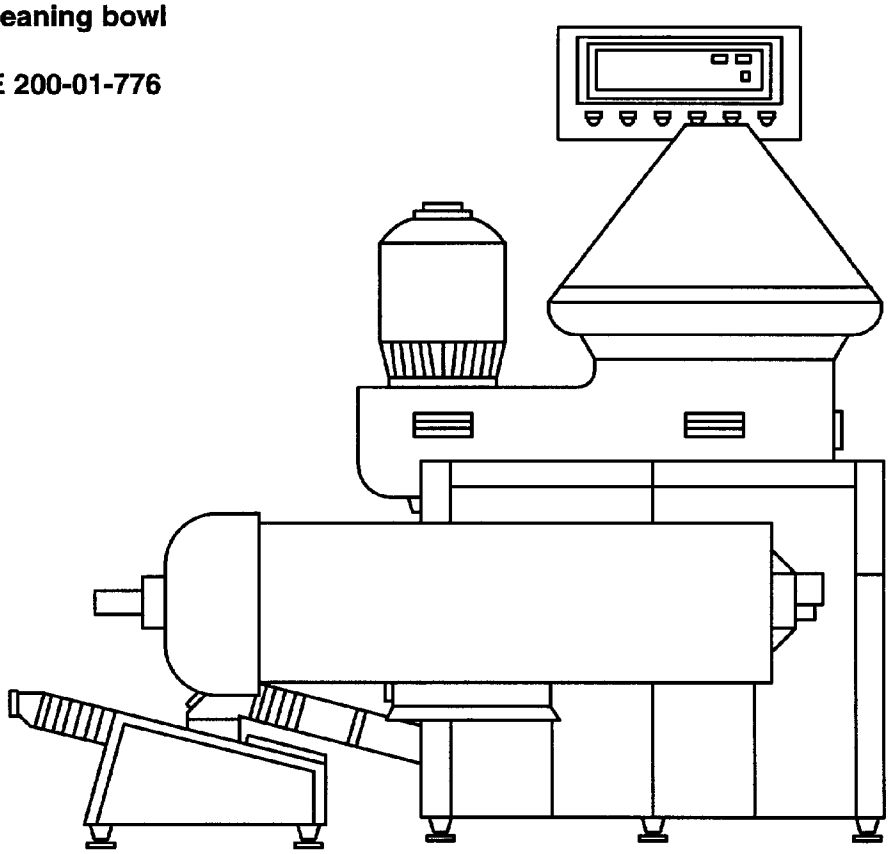
Instruction Manual and Parts List

No. 2294-9001-010

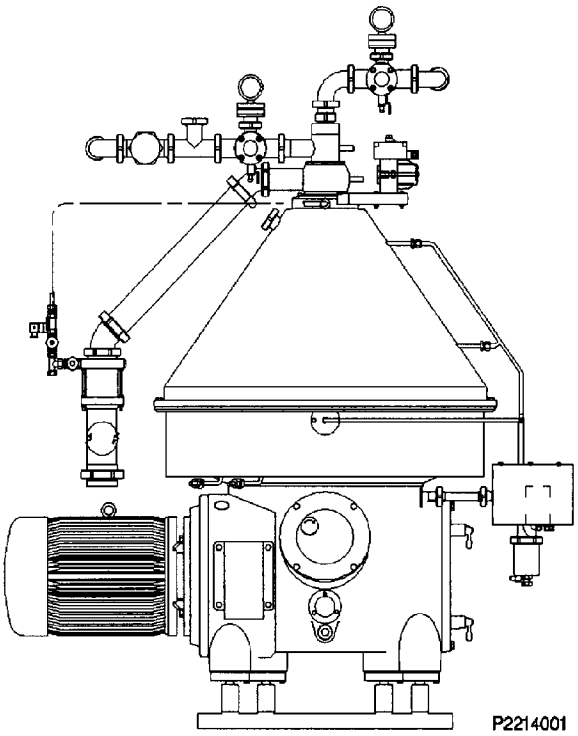
Edition 1296

Separator
with self-cleaning bowl

Model RSE 200-01-776



GEA
Process Technology
Division



Westfalia Separator AG
D-59302 Oelde (F. R. Germany)

Type		No.	
built in		inner Ø of bowl mm	
Rpm of bowl			
Permissible density of product to be treated			
heavy liquid kg/dm^3		solids kg/dm^3	

For your safety



- **Strictly adhere to instructions marked with this symbol**

  This avoids damage to the machine and other units.



- **Take special care when carrying out operations marked with this symbol -**

  otherwise danger to life.

- **Observe accident prevention regulations**

  The local safety and accident prevention regulations apply unconditionally to the operation of the separator.

- **Instruction manual**

  Follow only the instructions given in this manual

- **Operate the separator only in accordance with agreed process and operating parameters**

- **Maintain the separator as specified -**

  in this manual

- **Carry out safety checks on the separator -**

  as described in chapter "Safety precautions" in this manual

- **Liability for the function of the machine passes to the owner**

  Liability for the function of the machine passes unconditionally to the owner or operator irrespective of existing warranty periods in so far as the machine is improperly maintained or serviced by persons other than Westfalia Separator service personnel or if the machine is not applied in accordance with the intended use.

  Westfalia Separator AG shall not be liable for damage which occurs as a result of non-observance of the above. Warranty and liability conditions in the Conditions of Sale and Delivery of Westfalia Separator AG are not extended by the above.

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Safety precautions

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1.1 Correct usage

The separator is designed

- in accordance with the chemical and physical properties of the product specified by the customer and
- in accordance with the method of application of the separator agreed with Westfalia Separator AG.

In particular, products not conforming to the specifications the nameplate may not be used.

Any mode of operation deviating herefrom is not proper and correct.

Prior to any intended deviation from the agreed operating mode, it is therefore imperative to obtain the consent of WestfaliaSeparator AG.

1.2 Safety stickers on the machine

The following warnings must be attached to the machine as self-adhesive stickers. The stickers must always be in perfect condition.

- Clean dirty stickers.
- Replace damaged stickers.

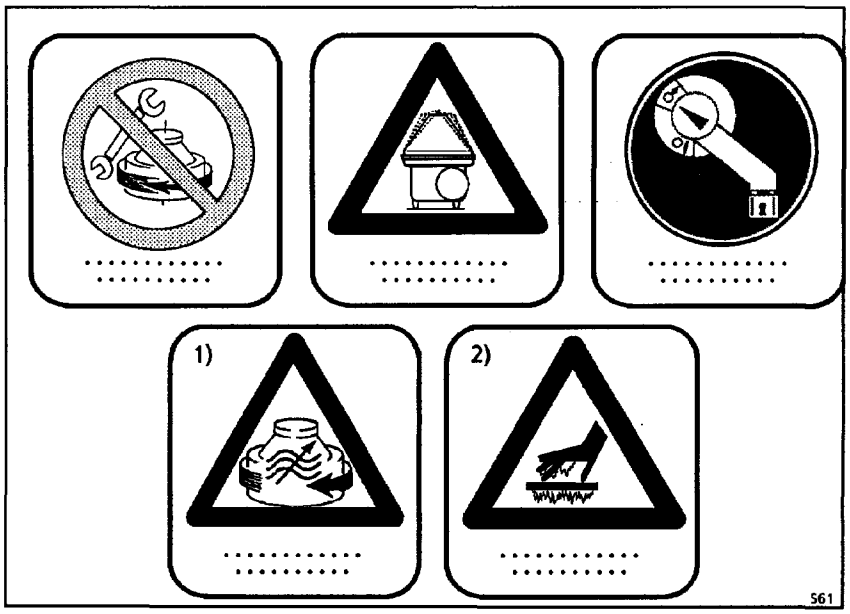


Fig. 1

1) Only in case of operation with frequency converter

2) Only in case of hot operation

1.3 Basic operating principles

Separators are used for the separation of liquid mixtures or for the separation of solids out of liquids or liquid mixtures.

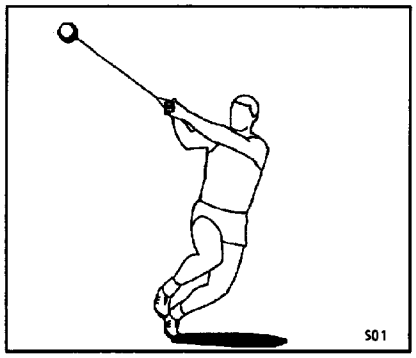


Fig. 2

High centrifugal forces are produced in the rotating bowl.

Under the influence of the centrifugal forces, separation of the liquid mixture and/or ejection of the solids particles takes place most rapidly.

The specifically heavier components are displaced to the bowl periphery, whereas the specifically lighter components are displaced towards the centre of the bowl.

The high centrifugal force is produced by very high bowl speeds. On the one hand, high bowl speeds signify high efficiency, while on the other hand, they signify high material stressing of the separator.

1.4 Bowl speed and product

The max. permissible bowl speed is an important parameter when rating the separator. It depends on the chemical and physical properties of the product such as

- temperature (if higher than 100 °C or lower than 0 °C),
- density of the fluid and solid components,
- aggressiveness of the product as regards corrosion and erosion (has influence on the selection of the bowl material).

The bowl speed is determined on the basis of these parameters allowing for an adequate safety margin.

Before using a product with properties different from those stated when placing the order, it is imperative to obtain the manufacturer's approval.

1.5 Operations on the separator

The separator works reliably, provided that it is operated and looked after in accordance with our operating Instructions.

Special attention must be given to:

- assembly
- starting
- shutting-down
- maintenance and servicing

1.5.1 Assembly

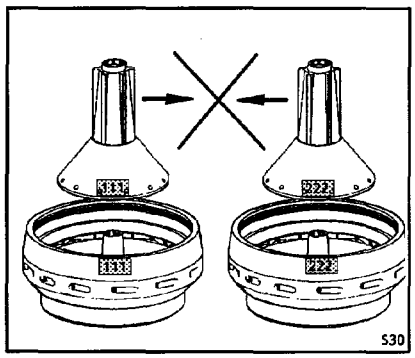


Fig. 3

- If the plant has several centrifuges, be careful not to interchange parts of different bowls since each bowl has been balanced individually.
  The bowl parts are marked with the serial-number of the machine or with the last three digits of the serial-number.

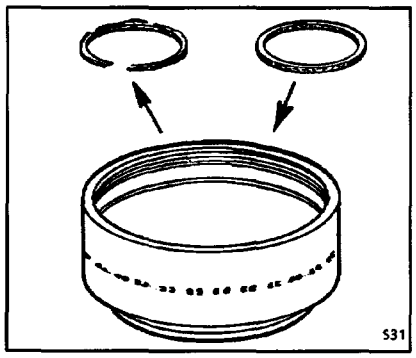


Fig. 4

- Damaged parts must be replaced immediately by new parts.

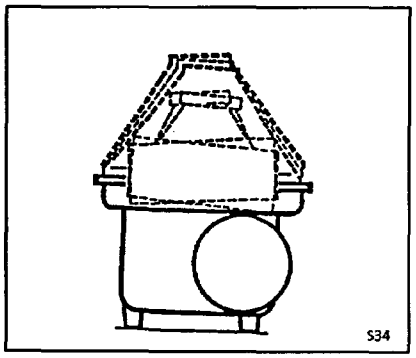


Fig. 5

- After installing spare bowl parts, the bowl must be re-balanced.

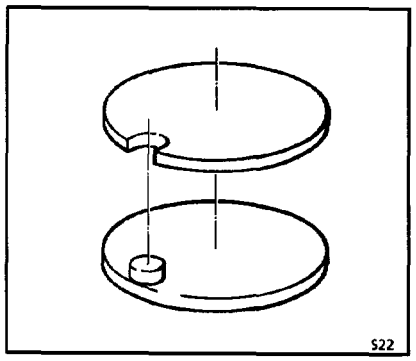


Fig. 6

- The bowl parts are arranged in fixed positions relative to one another.
- Locking devices and alignment marks must be in perfect condition.
  The bowl must not be operated if these locking devices and alignment marks are not in perfect condition.

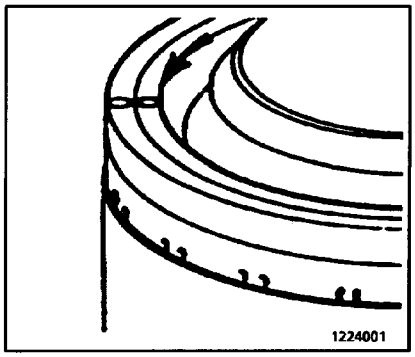


Fig. 7

- When assembling the bowl, be sure to strictly adhere to the instructions given in chapter "bowl", in order to avoid undue unbalance.
- Before starting the bowl, be dure to fit all parts.
- Tighten the bowl lock ring securely: the "O" marks on the bowl bottom or bowl top and on the lock ring must be in line with each other.

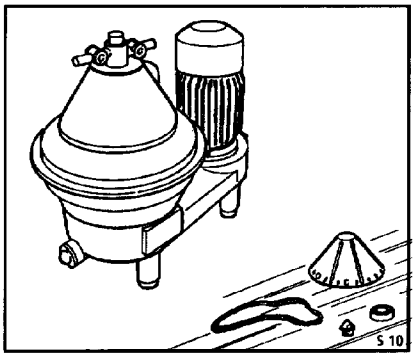


Fig. 8

- Check if the machine is completely assembled and properly installed.

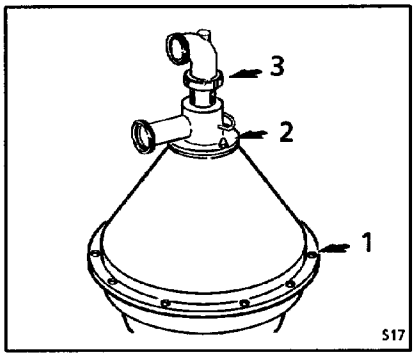


Fig. 9

- Carefully fasten hood 1, feed and discharge housing 2 and centripetal pump 3.

1.5.2 Electrical appliances

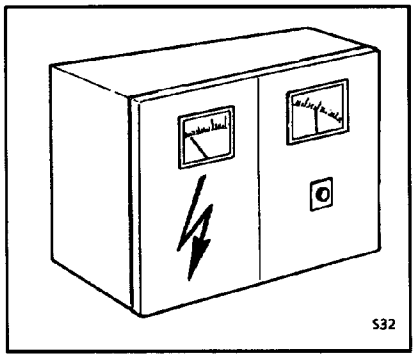


Fig. 10

- The governing accident prevention regulations apply for the electrical appliances and installations.
- The frequency and voltage of the power supply must correspond to the machine specifications.
- Carry out potential equalization.
- Observe legal regulations; e.g. in the EU:
  - Low-voltage guideline 73/23/EWG
  - Electro-magnetic compatibility 89/336/EWG.

1.5.3 Before start-up

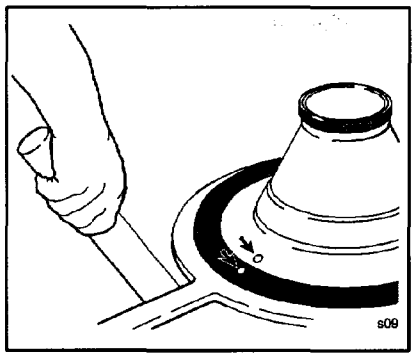


Fig. 11

- Check that the bowl lock ring has been firmly tightened.
- The "O" marks on bowl bottom or bowl top and on the lock ring must be aligned.

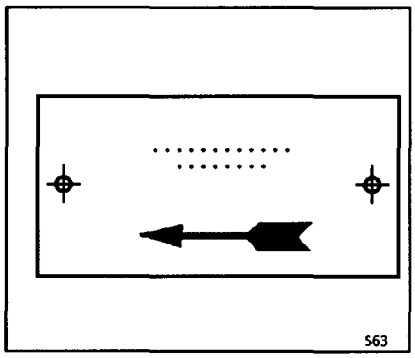


Fig. 12

- The bowl must rotate in clockwise direction (see arrow on frame or solids collector).

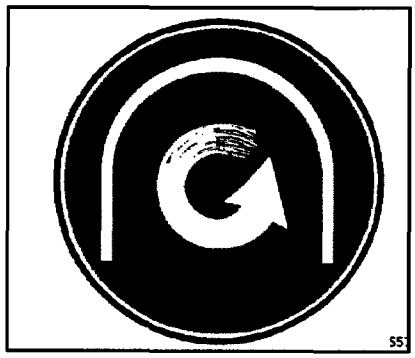


Fig. 13

- The separator may only be operated with protection devices conforming to EN 294.
  Equip solid and liquid discharges accordingly.

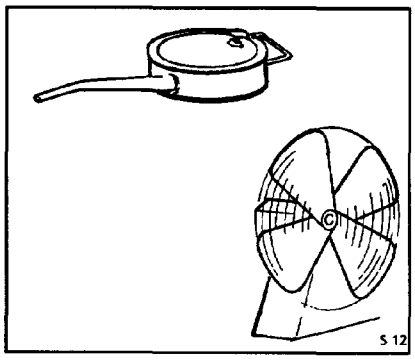


Fig. 14

- Check that the lubrication and cooling systems are serviceable.

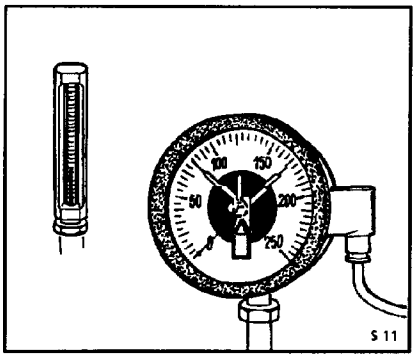


Fig. 15

- Check whether the supervisory equipment is operational and the correct limit values are adjusted.
- When hoods, concentrate collectors and vessels are pressurized, e.g. by
  - inert gas,
  - cooling,
  - steam sterilization etc.

  the pressures stated on the nameplate must not be exceeded.

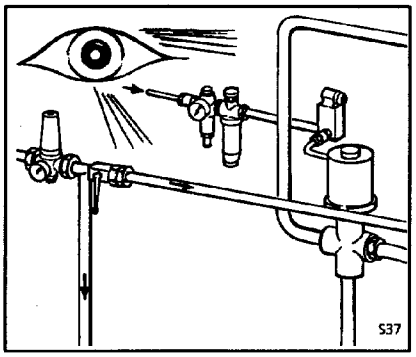


Fig. 16

- Check that the product lines are set to operation.
- Regularly check hoses for signs of ageing.
- Check sight glasses for mechanical damage.
- Replace damaged parts by parts which are as good as new.

1.5.4 Operation

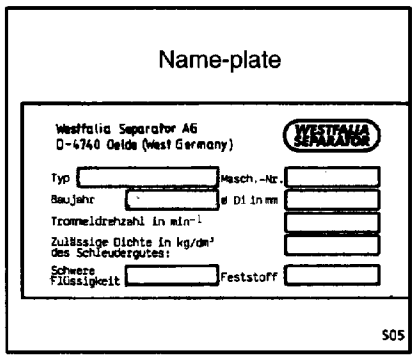


Fig. 17

- Refer to chapter »operation«.
- Note nameplate. The values for
  - bowl speed
  - density of the heavy liquid,
  - density of solids (centrifugally dry)

  are max. values and must not be exceeded.



Fig. 18

- Wear ear protection.



Fig. 19

In case of frequency converter operation:

- Do not under any circumstances manipulate the frequency converter to exceed the permissible bowl speed (see maker's nameplate).
- The separator may only be operated with an independent device for speed limiting.



Fig. 20

- Do not feed product which is categorised as explosive.
- The separator must not be used in areas where explosion protection is required.



Fig. 21

- When processing products harmful to persons, observe the pertinent safety regulations.
- Refer to the safety data sheet of the product.
- Wear protective clothing.

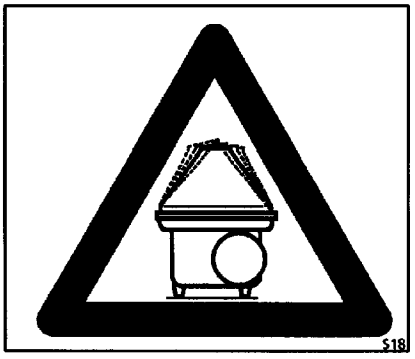


Fig. 22

- Stop the separator immediately if unusual noises or vibrations occur.



Fig. 23

Only in case of hot operation:

- Product-contacting parts such as
  - pipes and hoses,
  - hood,
  - solids collector

  reach temperatures over 80 °C.

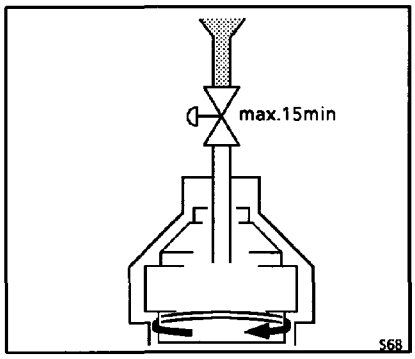


Fig. 24

- The bowl is not allowed to run without liquid supply for more than 15 minutes, as otherwise it would result in overheating of the bowl material.

1.5.5 Shut-down and »Emergency-Off«

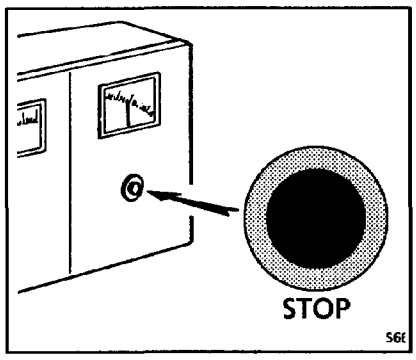


Fig. 25

- For shut-down refer to the chapter "operation".

1.5.6 Maintenance and repair

Unfavourable operating conditions may require shorter maintenance intervals. The factors listed below are unfavourable because they either attack the separator material directly or impair the lubrication/cooling system:

- aggressive product (chemical or physical)
- high product temperature
- product with grease decaying properties
- environment: temperature, dust and vapours

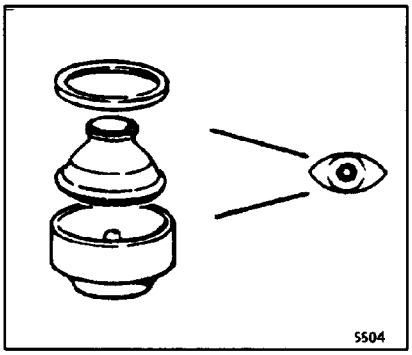


Fig. 26

Particularly stressed parts such as bearing hub, bowl hub and other bowl parts with a large outer diameter must be checked on a regular basis to ensure safe and efficient operation.

Timely maintenance and replacement of worn or damaged machine parts is essential for safe operation of the machine.

Maintenance and repair work may only be carried out by the customer to the extent as described in this instruction manual.

Stop

Maintenance and repair work not described in this manual may only be carried out by the manufacturer or by "repair shops" authorized by the manufacturer.

We, therefore, recommend in your own interest to have your separator inspected by our service engineers at regular intervals. Such inspections will keep your separator working reliable and prevent undesirable shut-downs.

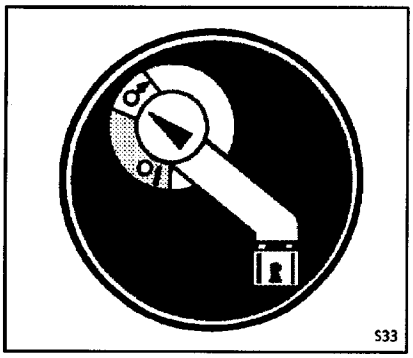


Fig. 27

Before maintenance and servicing:

- switch off all electrical appliances via the main switch,
- secure installation against unintended re-starting with locking devices.

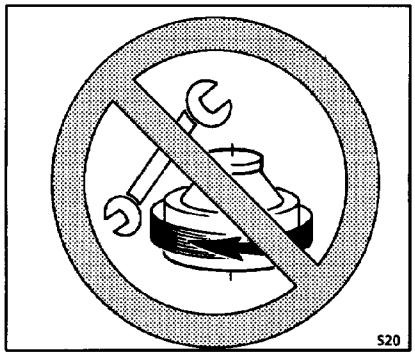


Fig. 28

- **Do not loosen any part before the bowl has come to a standstill.**
- For checking standstill refer to chapter "bowl".



Fig. 29

- Do not climb onto or stand on the machine or parts of the machine.
- Make provision for and use a sturdy working platform.

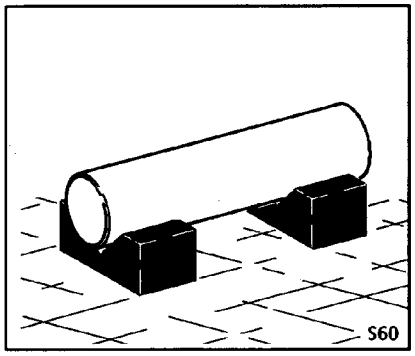


Fig. 30

- Place dismantled machine parts on a suitable base, e.g. rubber mat.
- Take steps to prevent machine parts from overturning and rolling away.

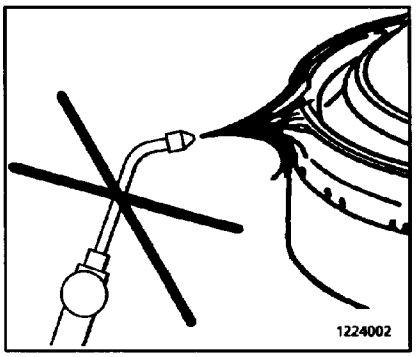


Fig. 31

- **Do not heat bowl parts with the naked flame.**
- **Bowl parts must never be welded. This also applies for hood and solids collector parts of steam-sterilizable separators.**
- Even during cleaning the bowl parts the temperature must not exceed 100 °C.

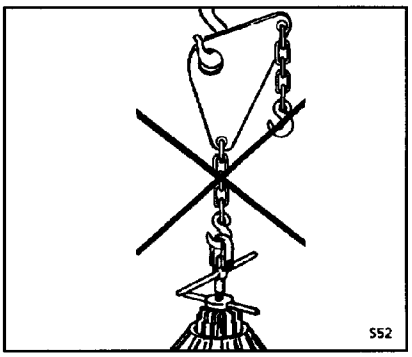


Fig. 32

- Load-carrying equipment such as lifting devices for
  - bowl or distributor,
  - chains etc.

  may only be used for work routines as described in this instruction manual.
- Do not use damaged or incomplete load carrying equipment.

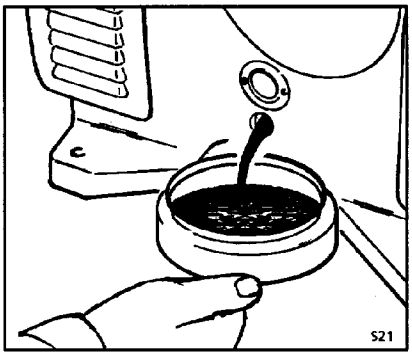


Fig. 33

- Collect dripping oil to prevent danger of slipping or product infection.
- When handling waste oils note:
  - They can be injurious to health, depending on their chemical composition.
  - Waste oil must be disposed of in accordance with local regulations.

1.6 Corrosion

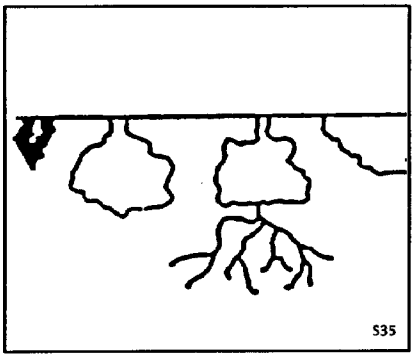
Corrosion can also affect bowl parts made of stainless steel. This corrosion can be flat-spread or pit- or crack-shaped and merits special attention.

Corrosion on stainless steel bowl material should be examined thoroughly and documented.

Flat-spread corrosion can usually be measured (reduction of wall thickness)

Pit- or crack-shaped corrosion cannot be measured without the risk of damage. At the initial stage pit-shaped corrosion is generally caused by chlorine ions.

Depending on the stressing of the part, pit-shaped corrosion can result in crack-shaped corrosion.



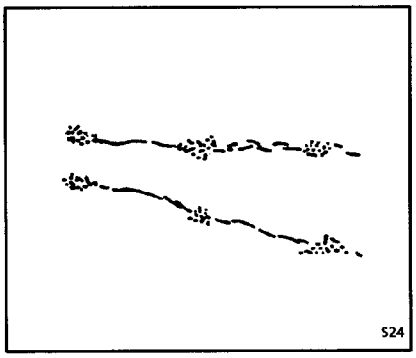
Possible formation of pit-shaped corrosion.

Fig. 34

Such pittings can only be investigated by a materials expert.

In case of crack-shaped corrosion attack with or without superposed flat-spread and pit-shaped corrosion on main bowl components, **the machine must be shut down immediately.**

Contact your nearest Westfalia Separator AG representative for a thorough examination.



Pittings

Pittings which are close together or form a linear pattern can signify crack formation beneath the surface.

Such pittings should be investigated by a materials expert.

Fig. 35

1.7 Erosion

Erosion is caused by solid particles in the process liquid.
These solid particles grind marks into the surfaces with which they come into contact.

The following factors favour the occurence of erosion:

- hard solids particles
- high throughput capacities

The first signs of erosion should be carefully observed and documented. Erosion can deepen rapidly, thereby weakening the bowl material.

Contact your nearest Westfalia Separator representative for a thorough examination. Information on the nature of the damage can be provided by photos, plaster casts or lead molds.

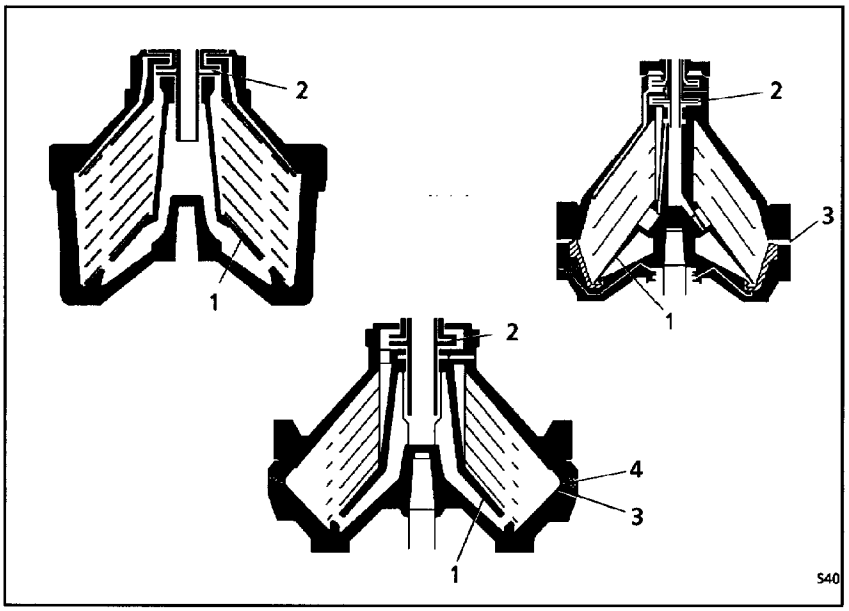


Fig.36

The surfaces most susceptible to erosion are:

1) the bottom of the distributor, the rising channels and the ribs,
2) the centripetal pump (cavitation),
3) all surfaces in the area of the solids discharge ports,
4) the nozzles.

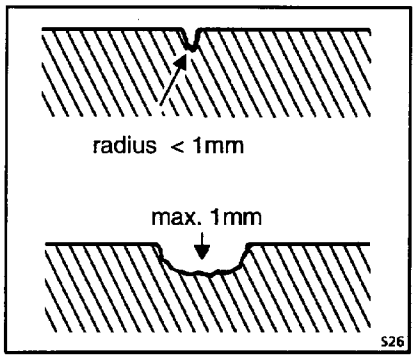


Fig. 37

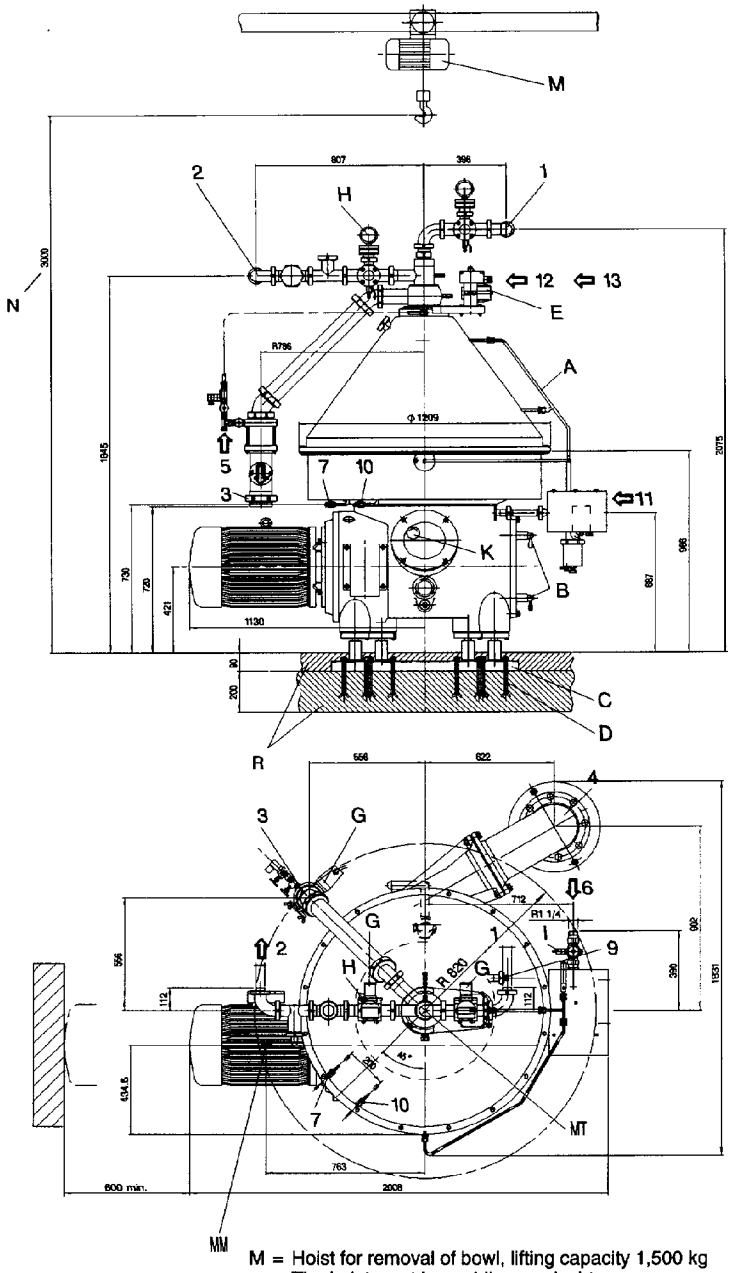
Signs of erosion which you should immediately report to your nearest Westfalia Separator representative:

- The bottom of the erosion mark has a radius smaller than 1 mm (large notch effect).
- The depth of erosion mark exceeds 1 mm at the deepest point.

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2 Installation

2.1 Transport 20
2.2 Installation 20



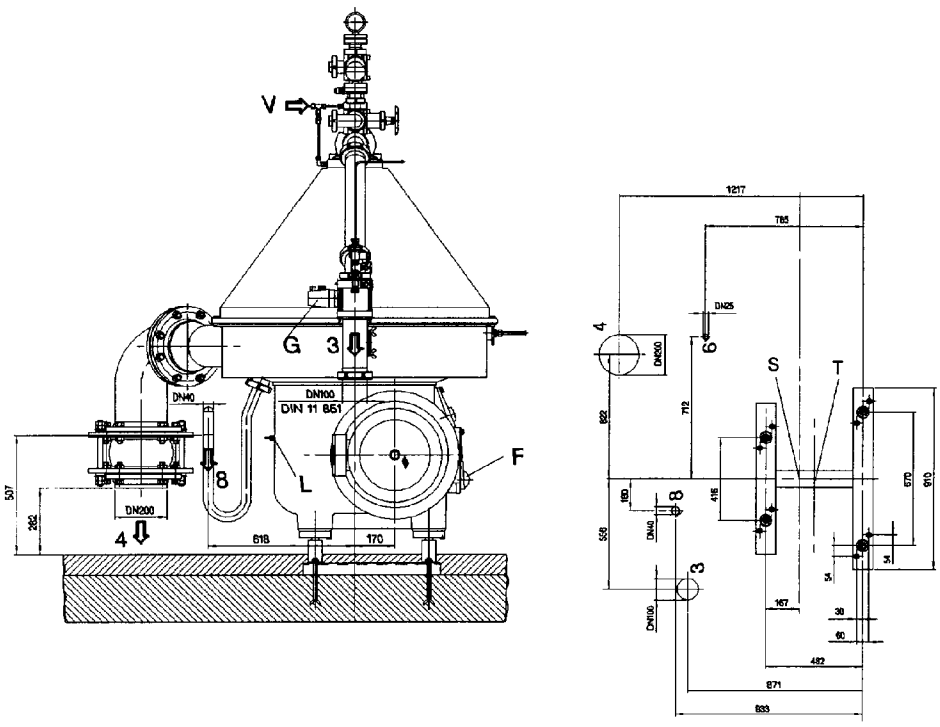
M = Hoist for removal of bowl, lifting capacity 1,500 kg
The hoist must be mobile or swivel-type.
It must be designed to fulfill the following tasks:
- Installing and removal of bowl in and from center "MT", in vertical direction
- Placing the hood and the bowl e.g. on the floor, in vertical direction
- Fitting and removing the drive motor in and from "MM"

= Min. lifting height for removal of bowl: 3,000 mm

2294-4100-031

Fig. 38

Subject to technical modifications - refer to project-related dimensioned drawing!



2294-4100-032

Fig. 39

Subject to technical modifications - refer to project-related dimensioned drawing!

Total weight = 2,910 kg			
Load on foundation			
static		29,100 N	
dynamic	horizontal	per foot: ± 10,000 N	
	vertical	per foot: ± 20,000 N	

1 Feed DN 50 DIN 11851
2 Light-phase discharge DN 50 DIN 11851
3 Heavy-phase discharge
4 Solids discharge
5 Flush water (solids-holding space of bowl and sight glass in light-phase discharge)
6 Operating water feed
7 Cooling water feed to solids collector
8 Operating-water discharge
9 Leaking-water outlet
10 Cooling-water discharge from solids collector
11 Control air (metering cylinder)
12 Instrument air for swivel-type actuator
13 Unit signal

A Hood flushing
B Brake
C Foundation frame
D Anchor bolt DIN 529
E "Fine Tuner" drive
F Oil sight glass
G Sight glass illumination
H Discharge-pressure monitoring
I Operating-water pressure monitoring
K Revolution indicator
L Clutch cooling water
S Center of bowl "MT"
T Center line foundation frame

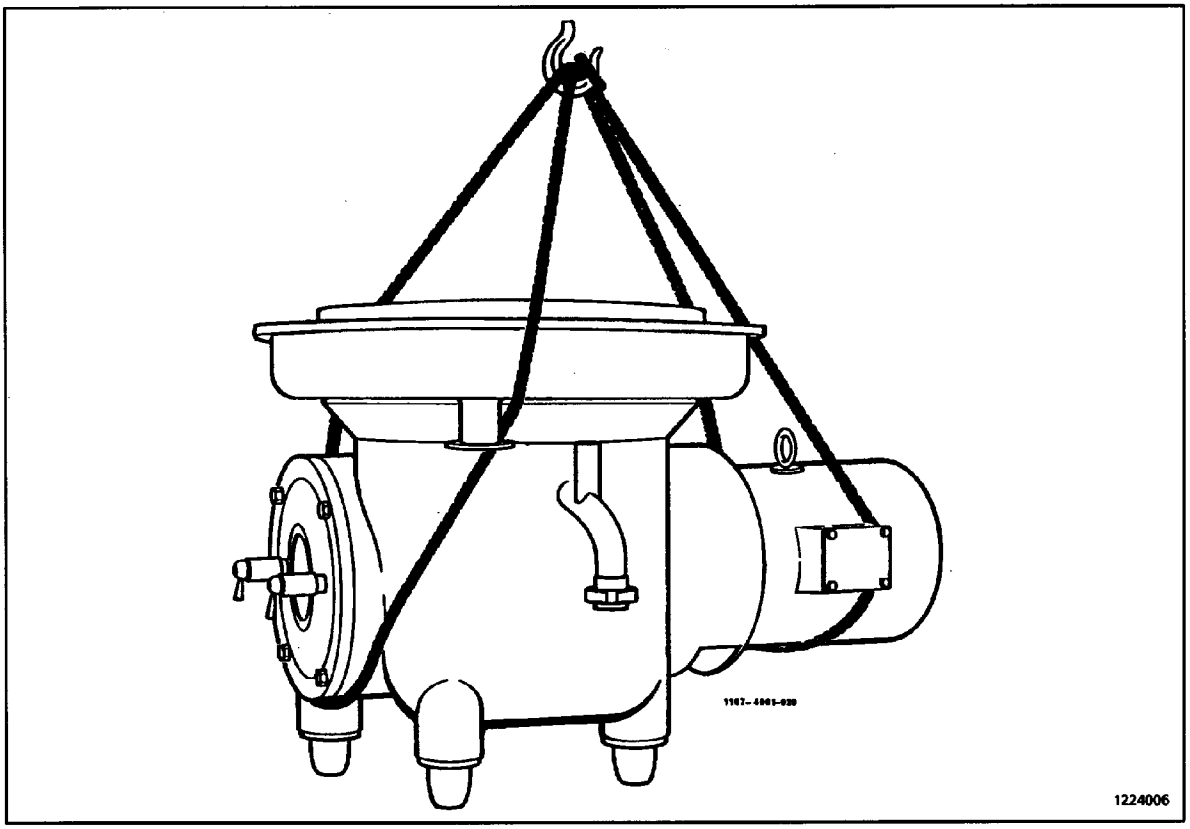


Fig.40

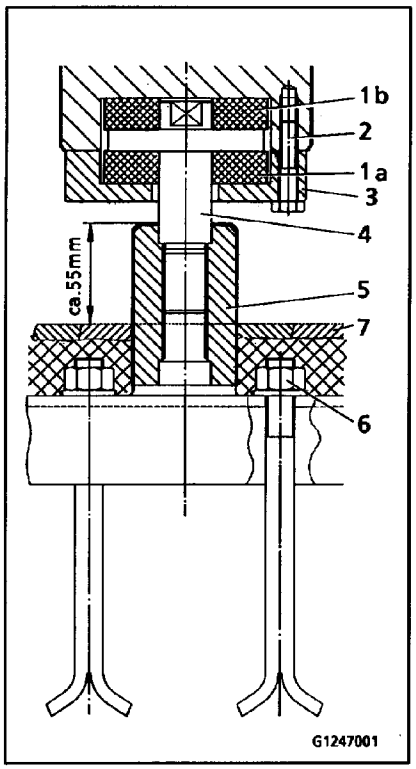
2.1 Transport

Suspend the separator as shown in figure.

- Never attach rope to eye bolt on motor.
- To prevent rope from slipping, wind it twice around the crane hook.
- When lowering the separator, make sure it touches down gently.

2.2 Installation

- When installing the separator, make sure that sufficient room is available to mount and remove the motor (see dimensioned drawing).
- Do not install a shut–off valve in the frame drain and do not connect this frame drain to a piping system. The operating water must be able to discharge freely into a sewer or sludge tank, e. g. via a funnel.
- Otherwise it will rise into the upper section of the frame, resulting in slowing down of the bowl. It can also seep down through the neck bearing into the gear chamber and damage the gear.
- For mounting and removing the bowl a 1 500 kg hoist is required.
- If possible use flexible tubes for connecting the feed and discharge lines of the separator to the permanent pipe lines so that vibrations occurring during start–up and slowing–down of the machine will be absorbed.



1 Rubber cushion
2 Screw
3 Flange
4 Bolt
5 Foundation frame
6 Heavy–duty plug
7 Floor

Fig. 41

- Screw bolt into the four cams of foundation frame 5 **as far as it will go.**
- Embed the foundation frame in the floor 7 so that the mounting blocks of the frame protrude from the floor by about 55 mm.
- Make sure that the mounting blocks are **absolutely level**. For fastening the foundation frame use anchor bolts 6.
- Remove bolts.
- Place the first rubber–metal cushion 1a and flange 3 on bolts 4.
- Screw in bolts again **as far as they will go.**
- Place the second rubber–metal cushion 1b on the bolts and place the separator on the bolts.
- Bolt flange 3 to the separator frame with screws 2.

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3 Lubrication

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3.1 Bearings and gear

All bearings of the centrifuge are splash–lubricated by:

- Immersion of the toothed rim of the worm wheel in the central oil bath. (All bearings are splashed with oil due to centrifugal force).

3.1.1 Oil quality (mineral oil)

As lube oil use industrial gear oils with the following designation:

- CLP 220 – DIN 51502
- CC 220 – ISO 3498

The lube oil must meet the following requirements:

Additives giving increased protection against corrosion and increased resistance to aging.		
Corrosion protection properties on steel:	degree of corrosion 0	DIN 51355/B
Corrosion effect on copper:	degree of corrosion 1	DIN 51759–100 A3
Additives for decreasing wear and increasing the load- carrying capacity.		
Basic requirement:	"FZG"gear rig test A/16,6/90 as per DIN 51534 load grade 12	
Demulsifying power: min	< 60	DIN 51599
Viscosity at 40 °C mm²/s (cSt)	220 ± 22	

The "CLP 220" gear oil (WS Part–No. 0015–0014–080) has been subjected to extensive tests and should be used!

Do not use motor vehicle gear or engine oils.

3.1.2 Oil quantity

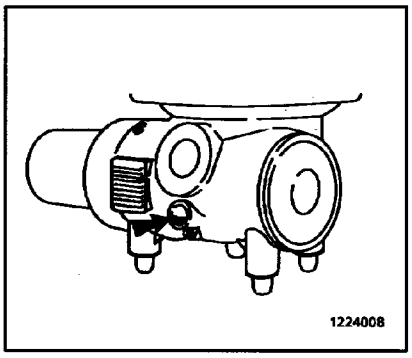


Fig. 42

- Before the initial start–up of the separator, remove gear sight glass and fill gear chamber with oil. About 5.5 litres of oil are required for one filling.

Minimum oil level:
slightly above middle of sight glass.

Maximum oil level:
up to the upper third of sight glass.

During operation the oil level must never be allowed to sink below the middle of the sight glass; refill oil when necessary.

3.1.3 Oil change

- Carry out the first oil change after approx. 250 operating hours.
- Subsequently every 750 operating hours; every 6 months at the latest.
- Whenever changing the oil thoroughly clean the gear chamber with thin–bodied oil.
- Carefully remove metal particles from the walls and corners.
- Do not use fluffy cleaning rags (no cotton waste)!
- Clean the sight glass.

3.1.4 Oil check

- Check the oil level every week!
- From time to time undo oil drain screw and check whether the oil contains water.

  If the oil sight glass shows a milky colouring (emulsification), change the oil immediately.

3.2 Bowl parts

Before assembling the bowl, lubricate threads as well as guide and contact surfaces.
This applies particularly to:

- Bowl bottom
- Bowl top
- Lock rings.

Use the lubricants specified below:

In the food industry:

- Klüber grease KSB 8 (can also be used in excess).

In the chemical industry:

- Gleitmo 800
- Molykote G
- Molykote G Rapid

Other lubricants with the same properties can be used; apply them sparingly.

During assembly do not let gaskets of the special material EPDM (ethylene-propylene-diene-caoutchouc)
Part-No.

0007-....-820, 0007-....-930, 0004-....-820, 0004-....-930

come into contact with mineral oils and fats.
(to prevent the gaskets from being destroyed by swelling up).

Silicon-based greases may be used to facilitate fitting.

3.3 Motor bearings

For lubrication of the motor bearings, refer to the instructions of the manufacturer (see motor plate).

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4 Motor connection

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4.4 Starting time 29

4.1 Three–phase AC motor

The separator is driven by a

- flange motor via
- fluid clutch and worm gear.

Motor power	30	kW
Connection	across–the–line or star–delta switch–over from star to delta 4 sec	
Starting current	1,8 – 2 x I_n	
Frequency	50 /60	Hz
Speed	1 500 /1 600	rpm
Type of protection	IP 55	
Motor protection	PTC resistors	

External voltage for the terminals of the temperature feelers **max. 2.5 volts**.

When testing for continuity, use an ohmmeter.
Never use a test lamp.

The measuring circuit line (between tripping device and motor)has to be laid separate from other lines.

Dimensioning of switches, wiring and fuses should be based upon the *starting current.*

4.2 Direction of rotation

The bowl must rotate clockwise when looked at from above.



- If it rotates in the opposite direction have two lead–in wires interchanged by a suitably qualified person.

4.3 Speed and starting time of the bowl

The bowl speed and the maximum permissible densities are stated on the nameplate of the separator.

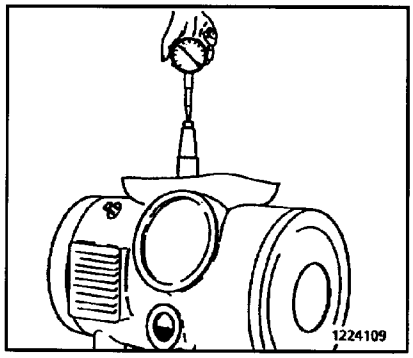


Fig. 43

- Check the spindle speed with a hand tachometer:
  - before initial start–up
  - after every gear change

Make this check before installing the bowl.

The spindle speed without bowl can exceed the rated bowl speed up to 5 %.

4.4 Starting time

Required starting time of bowl approx. 7–9 minutes.

Only *two* successive starts are permitted.
If, in exceptional cases, a third start becomes necessary, it must not be effected before 45 to 60 minutes have elapsed.

Why? The temperature of the oil in the fluid clutch will rise excessively.

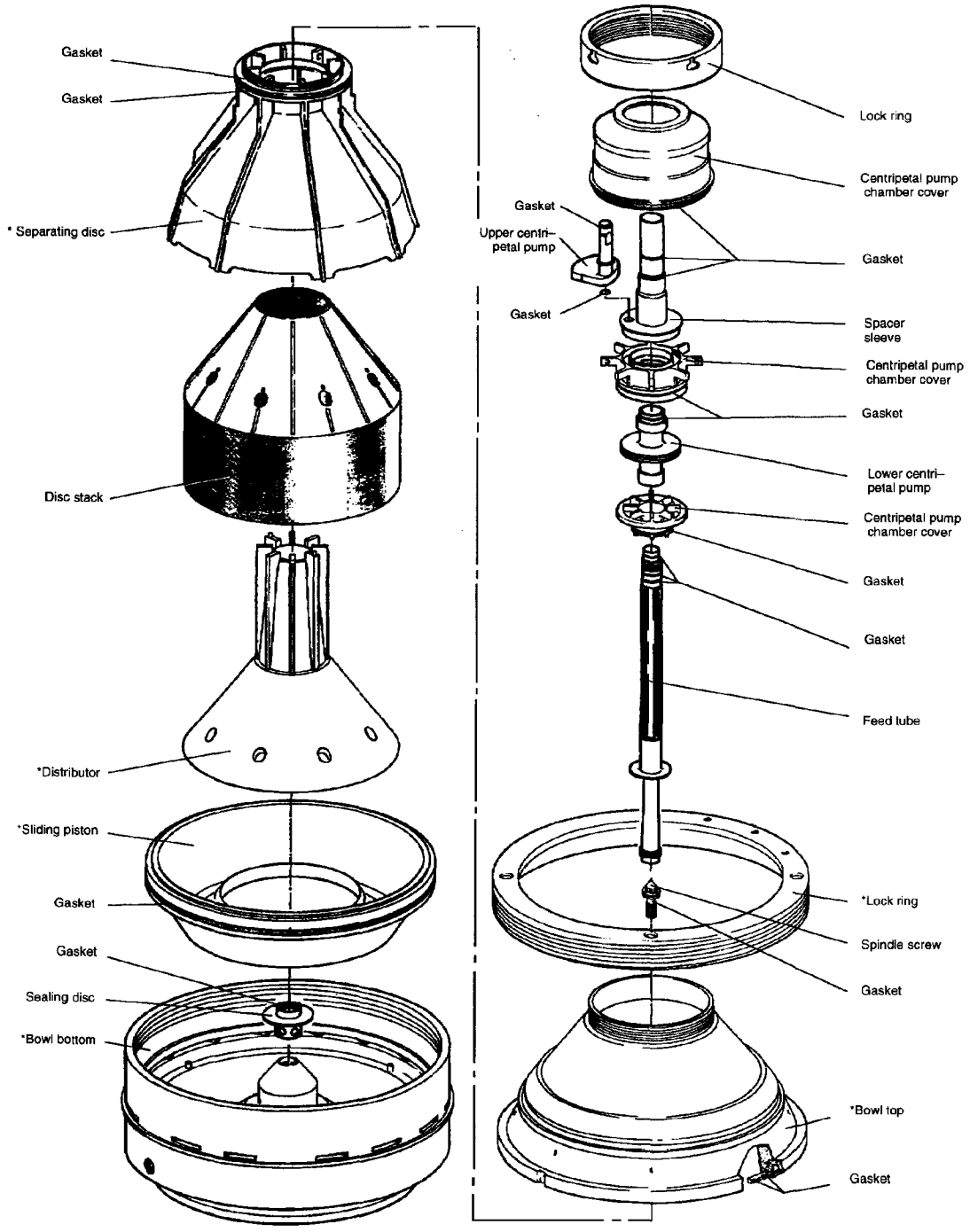


Make sure that the bowl reaches its rated speed within the starting time and that this speed is maintained during operation.

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5 Bowl

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5.9	Disk stack compressing device	60



*** NOTE:** After replacing this part, the complete bowl must be re–balanced.

Fig.44

5.1 Important hints

The clarifier bowl rotates at a very high speed.
Hence, forces are produced which can endanger the operating safety of the bowl in case of

- incorrect assembly or
- inadequate cleaning of the bowl.

The instructions for assembly must therefore be followed exactly.

The following points should also be observed:



- Before fitting the bowl parts thoroughly clean, grease or lubricate (3.2) the following and check for impact marks:
  - Guide and contact surfaces
  - Bowl lock ring
- Note that lubricating surfaces are clean.
- When fitting the bowl parts, make sure that the "O" marks on all parts are in line with each other.
  (Only then will the parts fit correctly over arresting pins and guide ribs).
- Avoid damage when fitting and removing parts by
  - exact positioning.
  - avoiding diagonal pull.
  - selecting the lower lifting speed of the hoist.



- Only use correctly rated, fully functional hoists.
- Do not use force to fit or remove parts.
- Before fitting gaskets, check the gaskets and gasket grooves for cleanness and wear.
- After fitting, check that the gaskets
  - are not twisted.
  - fit evenly into their grooves.
- Handle all bowl parts with care.
- Always place them on a rubber mat or pallet.

In the case of a plant with several clarifiers:



- Do not interchange parts of different bowls (danger of imbalance).

The bowl parts are marked with the serial number of the machine or the last three digits of the serial number.

5.2 Removing the feed and discharge connections

- Switch off the main switch and lock it so that it cannot be switched on again.

Attention!
To prevent accidents, do not loosen any parts before the bowl has come to a standstill!

Standstill of bowl is signaled by

- LED „bowl standstill" or
- the speed indicator in the control unit or in the motor control, or
- the revolution indicator, or
- standstill of the gear, to be seen through the sight glass in the frame.

- Be sure to replace worn gaskets immediately.
- For tools, see chapter 12.
- Stop compressed-air supply.

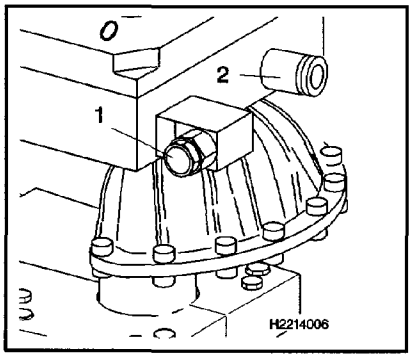


Fig.45

- Disconnect current supply line 1 and compressed-air supply line 2.
  Note:
  This has to be done **before** removing the protecting cases - **danger of crushing!**

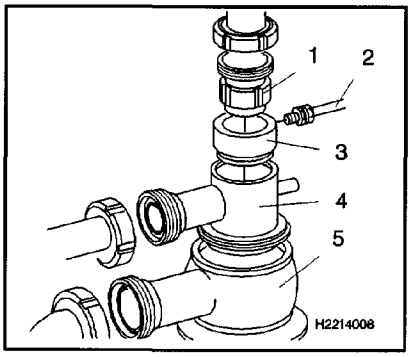


Fig. 46

- Disconnect the feed and discharge lines.
- Remove current supply to contact pressure gauge and sight glass illumination.
- Unscrew vent line 2.
- Unscrew connection piece 1.
- Lift off the following components:
  - vent piece 3,
  - upper discharge 4,
  - lower discharge 5.

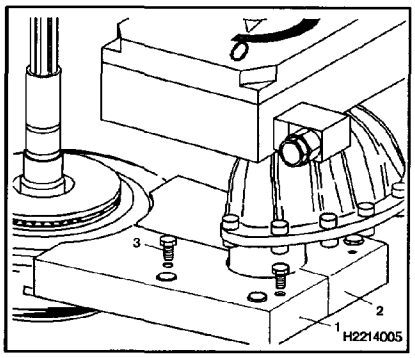


Fig. 47

- Unscrew hex head screws 3.
- Remove protecting-case halves 1 and 2.

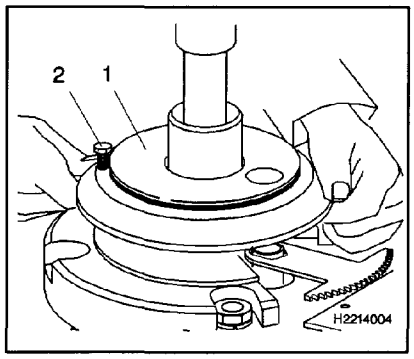


Fig. 48

- Lift off ring 1 or, if required, detach it by threading hex head screws into the tapholes provided.

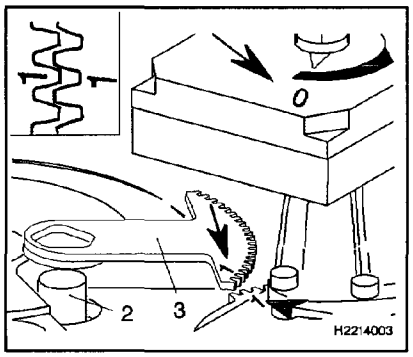


Fig. 49

- Remove toothed segment 3.

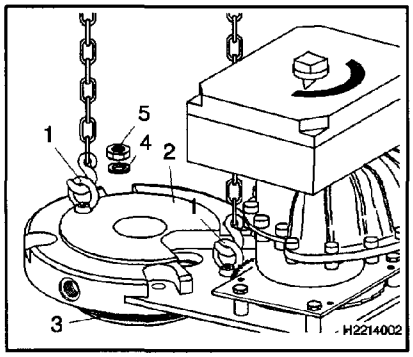


Fig. 50

- Unscrew hexagon nuts 5.
- Thread two eye bolts 1 into the tapholes.
- Lift off ring 2 together with swivel-type actuator. For the transport, use lifting device, if required (correct application is shown on Fig. 52).

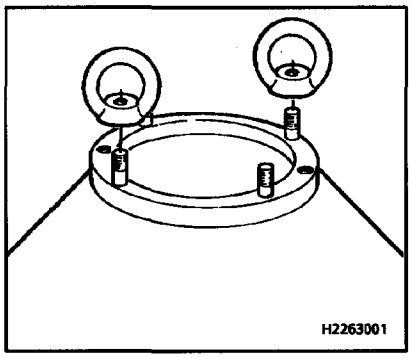


Fig. 51

- Screw two ring nuts opposite each other onto the studs of the hood.

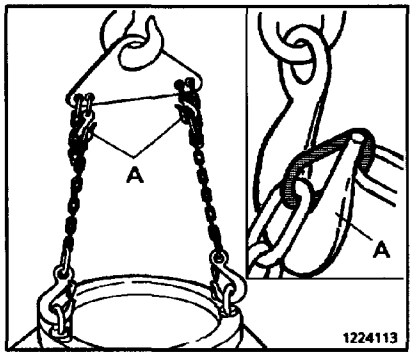


Fig. 52

- Unscrew the fastening screws of the hood.
- Shorten the chains of the lifting device.
- Hang the shortened lifting device into the lifting-eye nuts and lift off the hood.

5.3 Dismantling the bowl

- Switch off and lock the main switch.



Caution!
To prevent accidents, do not loosen any part of the machine until the bowl has come to a standstill!

Standstill of the bowl is indicated

- by the LED "bowl standstill" or
- by the speed indicator in the control unit or in the motor control or
- revolution indicator or
- gear standstill, visible through the sight glass on the frame.

- Replace worn gaskets immediately.
- For tools see chapter 12.
- Release brake before opening the bowl.

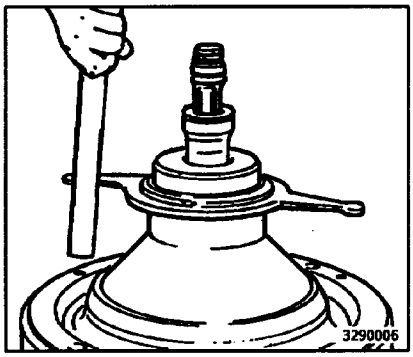


Fig. 53

- Unscrew centripetal pump chamber lock ring by lightly hammering against the handle of the annular wrench **(left–hand thread).**
- Lift off centripetal pump lock ring.

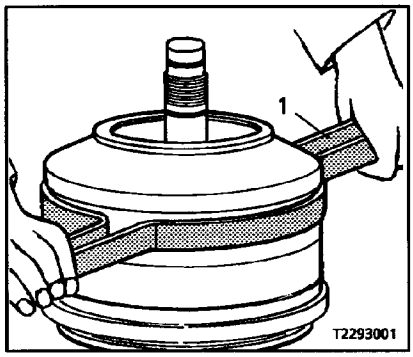


Fig. 54

- Lift off centripetal pump chamber cover using lifting tongs 1.

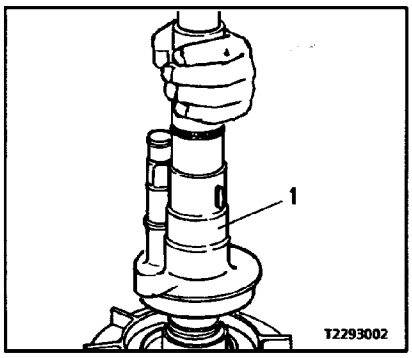


Fig. 55

- Pull off distance sleeve 1.

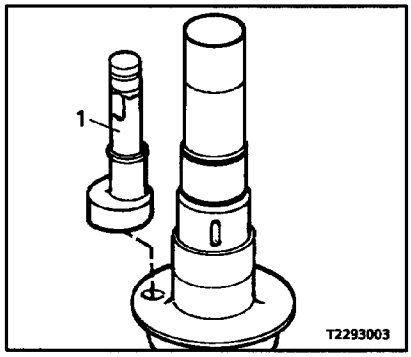


Fig. 56

- Remove upper centripetal pump 1.

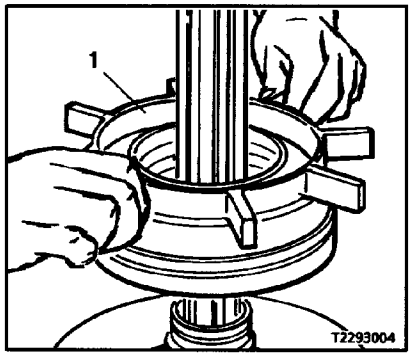


Fig. 57

- Lift off centripetal pump chamber cover 1.

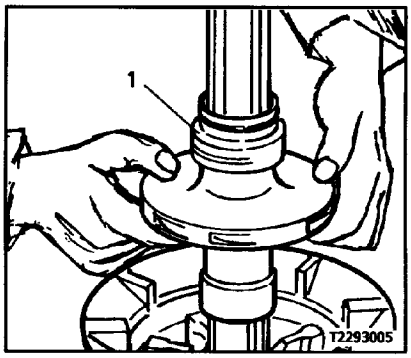


Fig. 58

- Pull off lower centripetal pump 1.

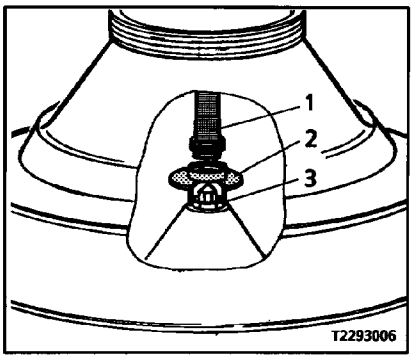


Fig. 59

- Place feed tube 1 with hydrodisk on hexagon 3 in the bowl bottom.
- Unscrew feed tube 1 from hydrodisk 2 by hand **(left–hand thread).**

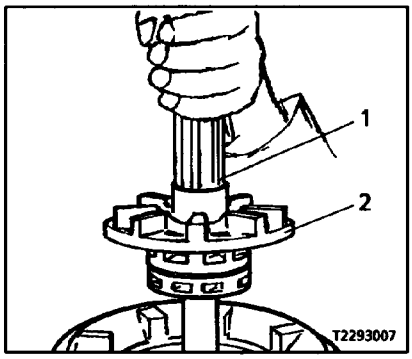


Fig. 60

- Lift out feed tube 1 with centripetal pump chamber 2.

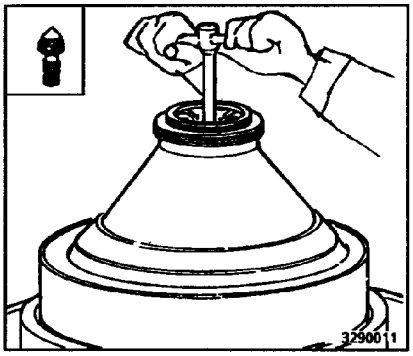


Fig. 61

- Unscrew spindle screw with wrench **(left–hand thread).**

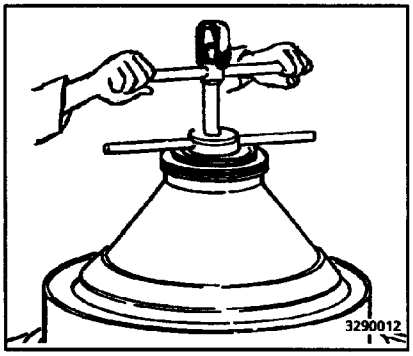


Fig. 62

- Force the bowl off the spindle cone using the jack (distributor/bowl).

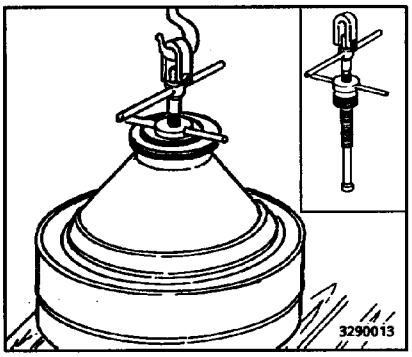


Fig. 63

- Place the bowl on a rubber mat or wooden pallet for further dismantling.

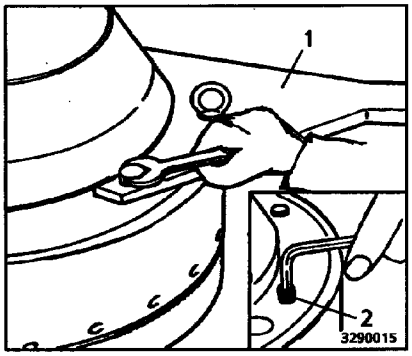


Fig. 64

- Unscrew threaded pins 2 out of the bowl lock ring.
- Fit wrench 1. Screw in screws of the wrench tightly.

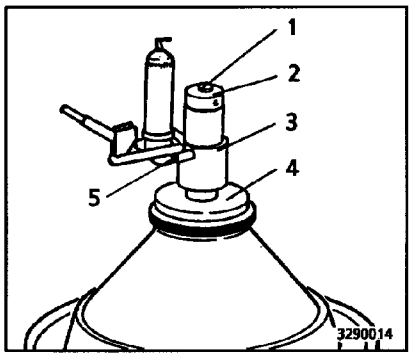


Fig. 65

Mount compressing device:

- Place disk 4 onto bowl top.
- Screw bolt 1 as far as it will go into the bowl bottom **(left–hand thread).**
- Insert hydraulic part 3 into the centering recess of the disk.
- Screw on threaded ring 2 until its upper edge is flush with end thread of bolt 1 **(left–hand thread).**

To prevent damage to threads:

- Screw in threaded bolt as far as it will go.
- Screw on threaded ring until end of thread.

If the threaded ring cannot be screwed down completely, then the piston and the cylinder of the compressing device are too far apart.

In this case:

- Bring piston and cylinder back into their starting position:
  - Loosen pressure relief screw 5 by two turns.
  - Move the pump lever to its lowest position.
  - Screw on threaded ring until end of thread.
- Tighten screw connections of the compressing device.
- Close pressure relief screw 5.

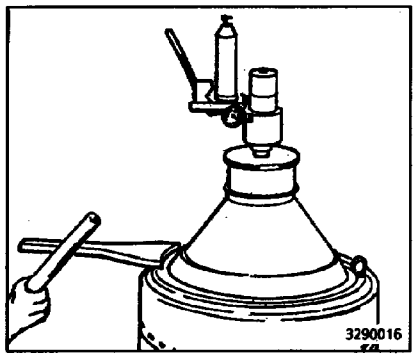


Fig. 66

- Compress disk stack to facilitate loosening of the bowl lock ring.
  Pressure: 250 bar
- Loosen the bowl lock ring by hammering against the handle of the wrench with a mallet **(left–hand thread).**

- If the lock ring is jammed, heat the upper part of the bowl bottom with steam or hot water.
  Other heat sources such as soldering lamp or welding torch **may not** be used.

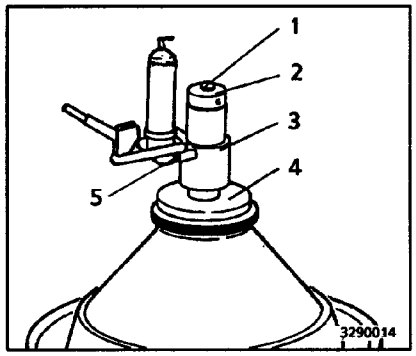


Fig. 67

Remove the compressing device:

- Move pump lever of compressing device down as far as it will go to prevent it from jumping back.
- Loosen pressure relief screw 5.
- Unscrew threaded ring 2 **(left–hand thread).**
- Remove hydraulic part 3 with disk 4.
- Unscrew bolt 1 **(left–hand thread).**

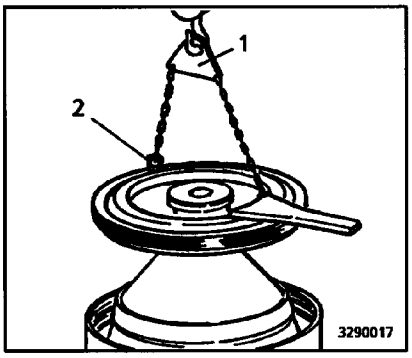


Fig. 68

- Unscrew bowl lock ring completely and lift it out using device 1 and eye bolt 2.

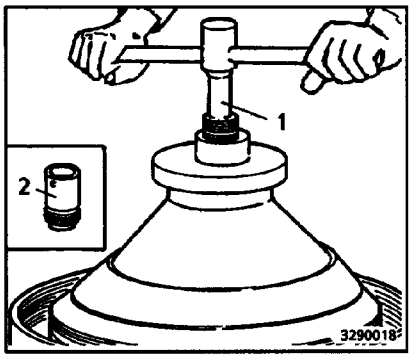


Fig. 69

- Screw pressure piece 2 of the lifting device (bowl top) into the distributor neck.
- Screw lifting device 1 onto the bowl top.
- Force the bowl top off the bowl bottom by turning the spindle clockwise and remove it.
- Unscrew pressure piece from the distributor neck.

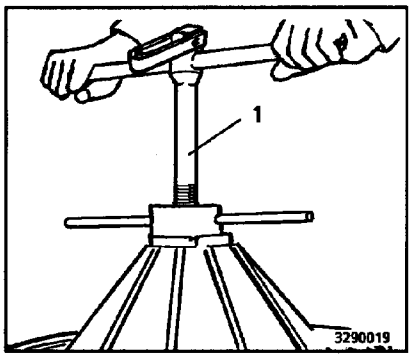


Fig. 70

- Screw lifting device 1 into the distributor.
- Press off distributor together with disk stack by turning the spindle clockwise.
- Lift out distributor with disk stack.

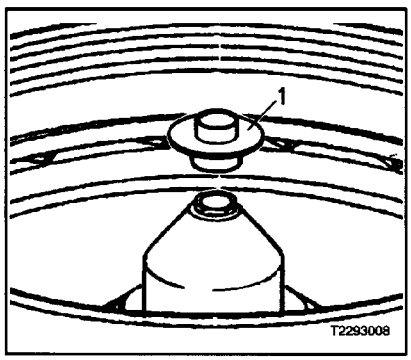


Fig. 71

- Take out hydrodisk 1.

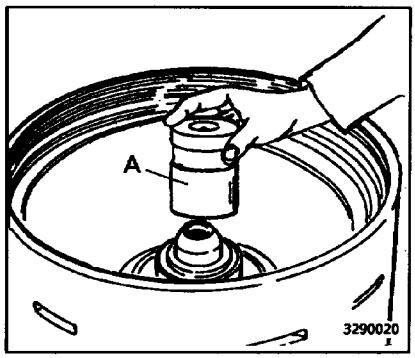


Fig. 72

- Place pressure piece A of lifting device (sliding piston) on the hub of the bowl bottom.
- Grease outer surface of the pressure piece.

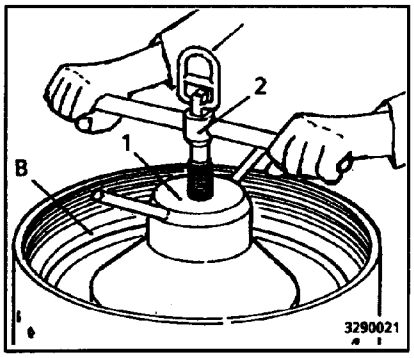


Fig. 73

- Screw lifting device 1 onto the sliding piston.
- Force sliding piston off the bowl bottom by turning threaded soindle 2 clockwise.
- Lift off sliding piston.
- Make sure that sealing lip B of the sliding piston does not get damaged.

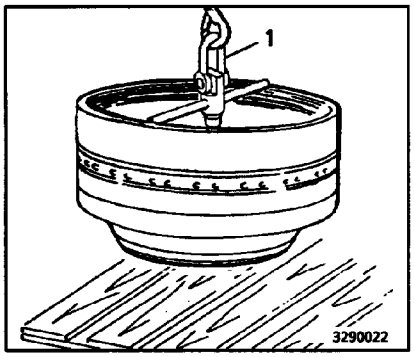


Fig. 74

- Use jack 1 for transporting the bowl bottom.

5.4 Assembling the bowl

- Assemble the bowl on a rubber mat or wooden pallet.
- For lubricating the threaded areas and guide surfaces of the bowl parts, refer to 3.2.

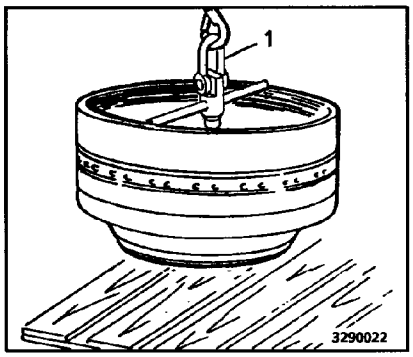


Fig. 75

- Use jack 1 for transporting the bowl bottom.

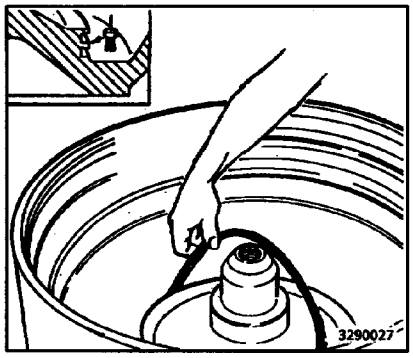


Fig. 76

- Thoroughly clean the two gasket grooves in the bowl bottom and apply a thin film of grease.
- Insert the gaskets into the grooves in the bowl bottom.

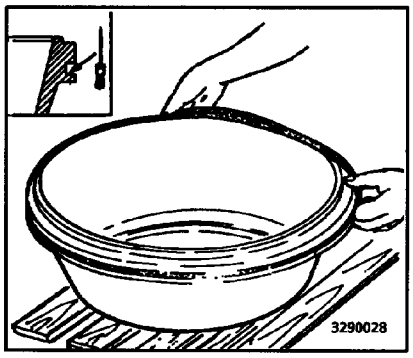


Fig. 77

- Thoroughly clean gasket groove in the sliding piston and apply a thin film of grease.
- If the gasket to be fitted is new, it must be stretched equally all the way round until its outer diameter almost corresponds to the outer diameter of the groove in the sliding piston.
- Insert gasket into the groove of the sliding piston.

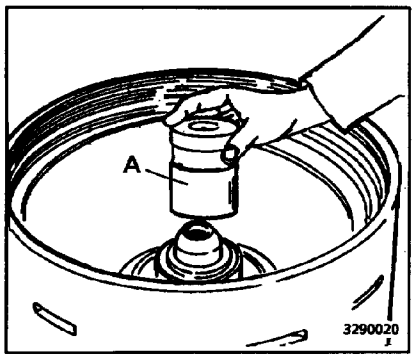


Fig. 78

- Place pressure piece A of the lifting device (sliding piston) on the hub of the bowl bottom.

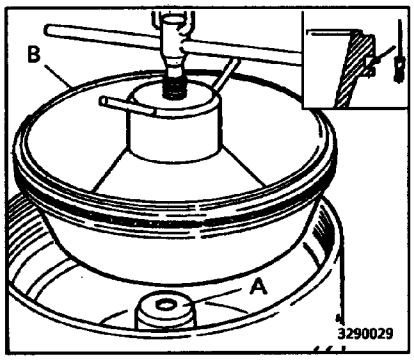


Fig. 79

- Grease guide surfaces of the sliding piston and bowl bottom.
- Insert the sliding piston using lifting device so that the "O" marks are perfectly aligned.
- Lower the sliding piston slowly by turning the jackscrew anti–clockwise until the arresting pins of the bowl bottom catch into the holes of the sliding piston. If necessary, wriggle the piston until it snaps into position.



- Be careful not to damage sealing lip B of the sliding piston.
- After inserting the sliding piston take out pressure piece A.

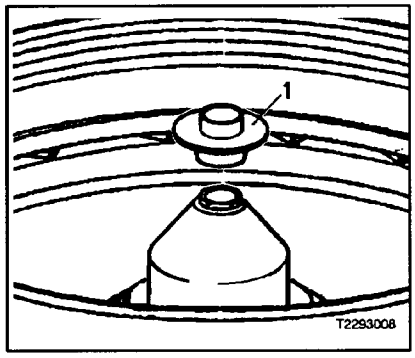


Fig. 80

- Insert hydrodisk 1.

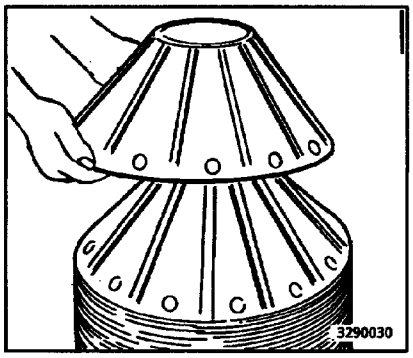


Fig. 81

- Stack the disks onto the neck of the distributor in numerical order, beginning with number 1.

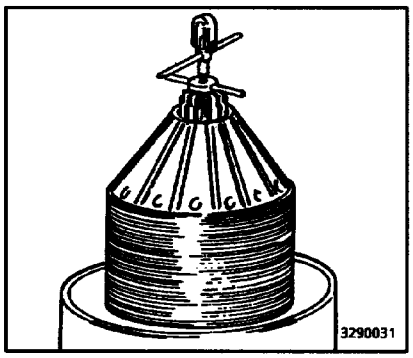


Fig. 82

- Grease the contact surfaces.
- Install distributor together with disks in the bowl bottom.

  The "O" marks on the bowl bottom and distributor must be aligned; the arresting pins in the bowl bottom will then catch into the holes of the distributor.

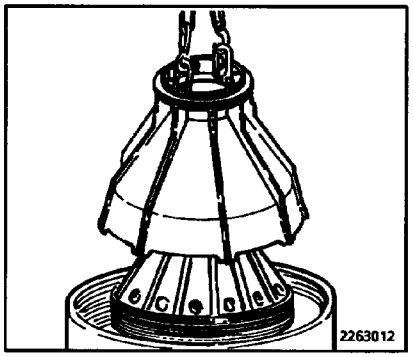


Fig. 83

- Install separating disk with inserted gaskets.

  The "O" marks on the separating disk and bowl bottom must be aligned.

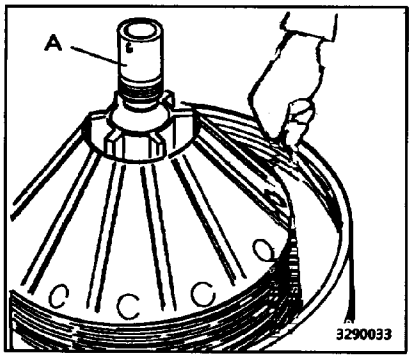


Fig. 84

- Clean and grease guide surfaces and threads of the bowl bottom.
- Screw pressure piece A into the distributor neck as a support for the lifting device (bowl top).

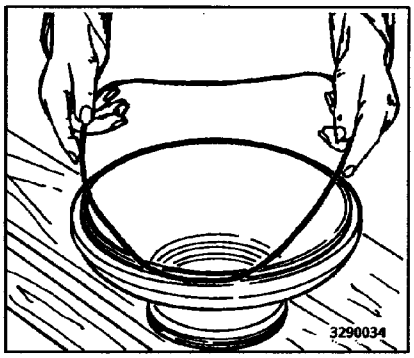


Fig. 85

- Insert gaskets into the grooves of the bowl top.
  If the main bowl gasket has to be replaced, see 5.6
- Clean and grease guide surfaces of the bowl top.

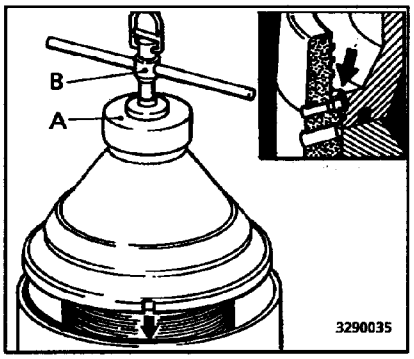


Fig. 86

- Place bowl top on bowl bottom using lifting device A.
  Slowly lower the bowl top by turning jackscrew B anticlockwise.
  Make sure that the arresting piece of the bowl bottom catches into the groove of the bowl top.
  The "O" marks of both parts must be aligned.
- Unscrew pressure piece from the distributor neck.

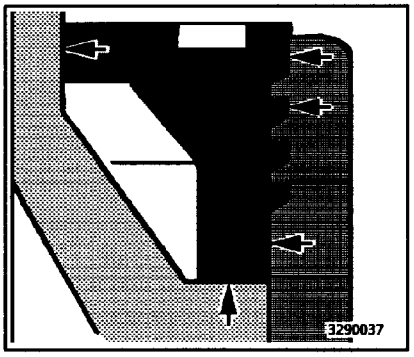


Fig. 87

- Check and grease threads as well as contact and guide surfaces (see arrows).

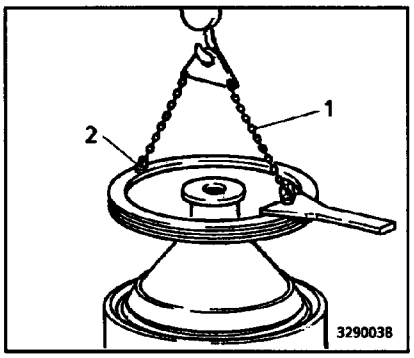


Fig. 88

- Place bowl lock ring on the bowl bottom using lifting device 1 and eye bolt 2.
- First screw in bowl lock ring using the wrench by hand **(left–hand thread).**

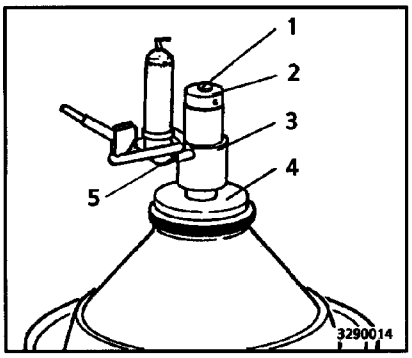


Fig. 89

Mount compressing device:

- Place disk 4 onto bowl top.
- Screw bolt 1 as far as it will go into the bowl bottom **(left–hand thread).**
- Insert hydraulic part 3 into the centering recess of the disk.
- Screw on threaded ring 2 until its upper edge is flush with end thread of bolt 1 **(left–hand thread).**

To prevent damage to threads:

- Screw in threaded bolt as far as it will go.
- Screw on threaded ring until end of thread.

If the threaded ring cannot be screwed down completely, then the piston and the cylinder of the compressing device are too far apart.

In this case:

- Bring piston and cylinder back into their starting position:
  - Loosen pressure relief screw 5 by two turns.
  - Move the pump lever to its lowest position.
  - Screw on threaded ring until end of thread.
- Tighten screw connections of the compressing device.
- Close pressure relief screw 5.

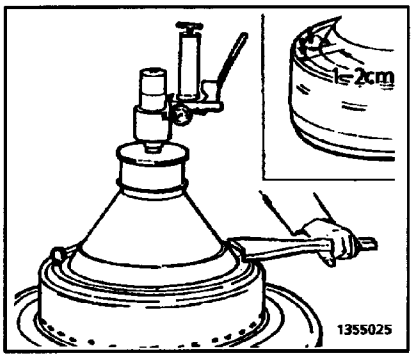


Fig. 90

Compressing the disk stack:

Pressure must be gradually applied to the disk stack until the max. disk compression of 250 bar is attained.

Each pressure increase should be approx. 150 bar.

After each pressure increase, tighten bowl lock ring further.

When the max. disk compression of 250 bar has been reached, the "O" mark on the bowl lock ring must be approx. 1 – 2 cm apart from the "O" mark on the bowl bottom.

If the maximum pressure is not attained and grease flows out of the stroke limiting hole, bolt 1 has not been screwe far enough into the bowl bottom.
The compressing device is not ready for use again until bolt 1 and threaded ring 2 have been brought back into the position as described above.

When compressing the disc stack, make sure that the arresting piece of the bowl bottom snaps into the groove of the bowl top and that the bowl top does not become tilted when lowered.

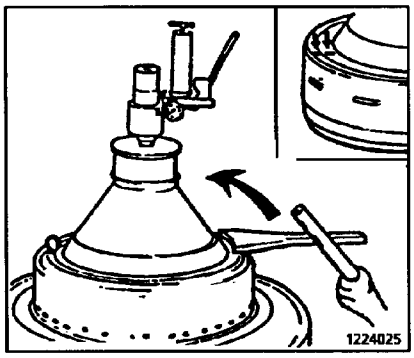


Fig. 91

- Hit wrench handle with the mallet **to obtain "O" mark alignment (left–hand thread).**

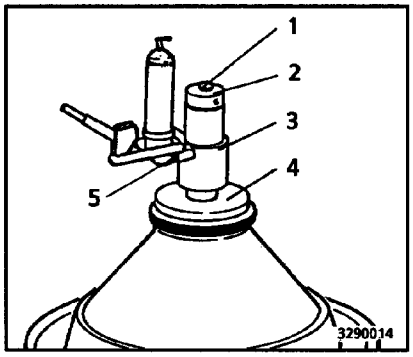


Fig. 92

Remove the compressing device:

- Move pump lever of compressing device down as far as it will go to prevent it from jumping back.
- Loosen pressure relief screw 5.
- Unscrew threaded ring 2 **(left–hand thread).**
- Remove hydraulic part 3 with disk 4.
- Unscrew bolt 1 **(left–hand thread).**

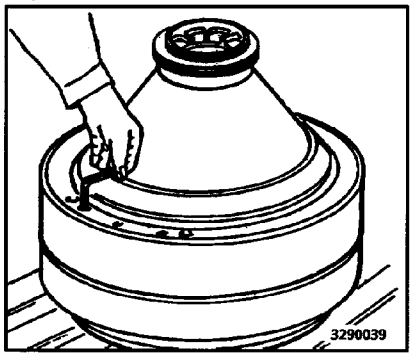


Fig. 93

- Unscrew the three hex head screws of the wrench and remove it.
- Unscrew the eye bolt.
- Glue the four threaded pins into the lock ring with Loctite 241 and screw in until they are **flush** using an Allen wrench.

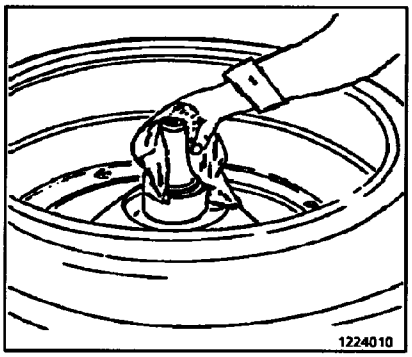


Fig. 94

- Before placing the bowl on the spindle, oil the upper part of the spindle (thread and cone).
- **Clean and dry** the conical part of the spindle and the inside of the bowl hub with a cloth to ensure proper fitting.

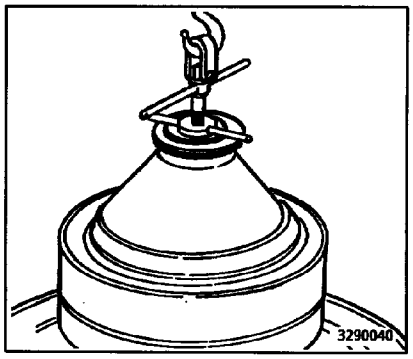


Fig. 95

- Place bowl on the spindle by means of lifting device (distributor).

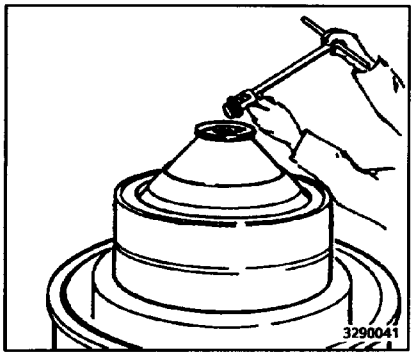


Fig. 96

- Screw spindle screw with inserted gasket firmly into the spindle **(left-hand thread).**

5.4.1 Fitting the centripetal pump

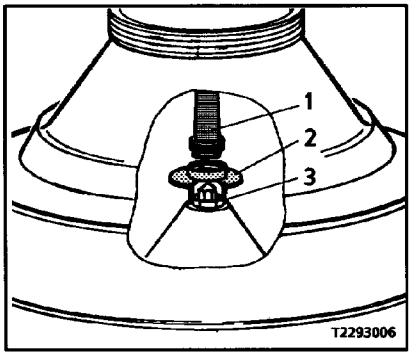


Fig. 97

- Screw feed tube 1 with inserted gasket into hydraulic disk 2 in the bowl bottom, by hand, and tighten firmly **(left-hand thread).**

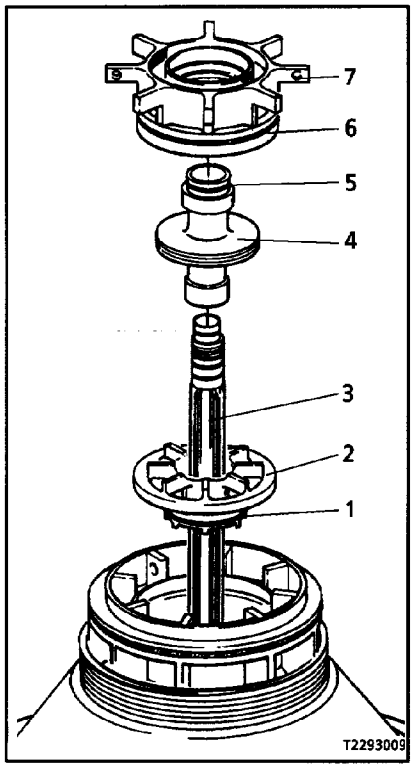


Fig. 98

- Place on centripetal pump chamber cover 2 with inserted gasket 1.
  Pay attention to correct positioning!
- 3 **Lift** feed tube and slip on lower centripetal pump 4 with inserted gasket 5.
  Pay attention to correct positioning!
- Place on centripetal pump chamber cover 7 with inserted gasket 6.
  Pay attention to correct positioning!

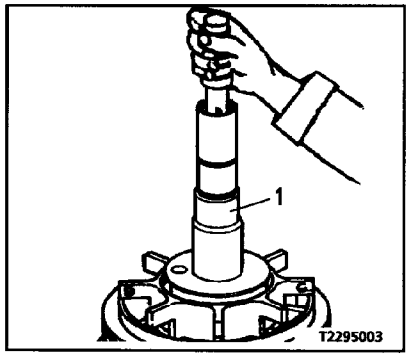


Fig. 99

- Lift feed tube.
- Slip on distance sleeve 1.
  Pay attention to correct positioning. If required, check if the centripetal pump components are assembled correctly.

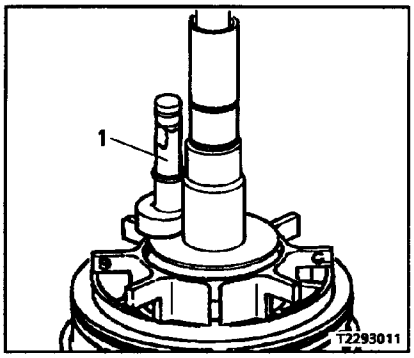


Fig. 100

- Clean upper centripetal pump 1 and grease the guide surfaces lightly (3.2).
- Insert upper centripetal pump 1 with fitted-in gaskets and incline it towards the bowl centre.

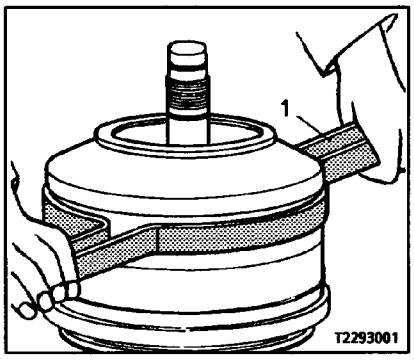


Fig. 101

- Place on centripetal pump chamber cover with inserted gasket.

  Pay attention to correct positioning!

  The "O" marks must be aligned.

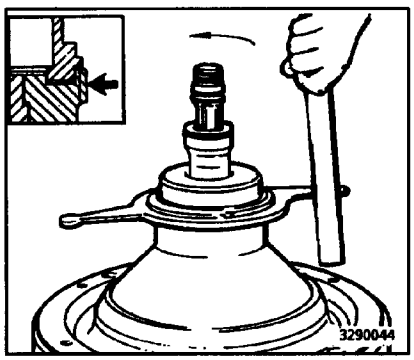


Fig. 102

- Clean and grease threads on bowl top and in the lock ring.
- Screw on the lock ring by hand and tighten it by hammering against the handle of the annular wrench **(left-hand thread).**

5.4.2 Installing the swivel-type actuator

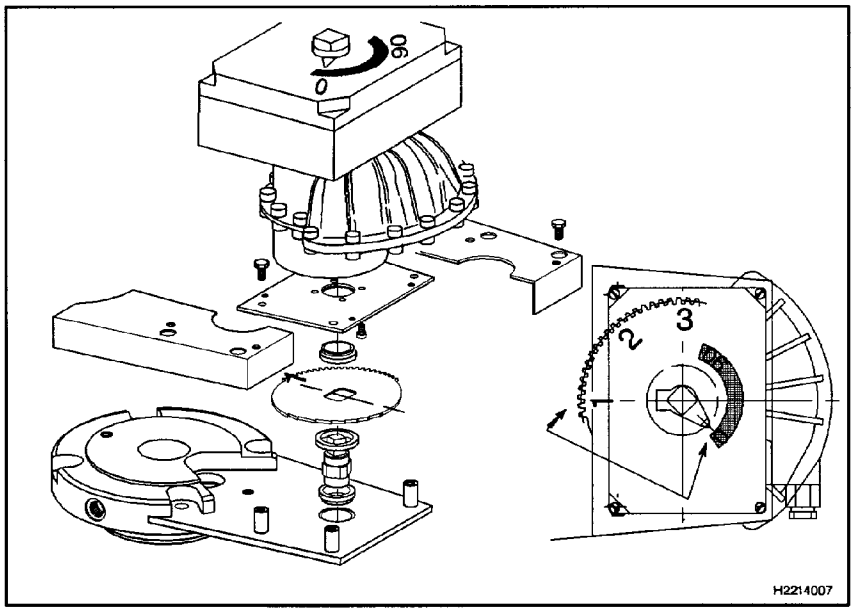


Fig. 103

Exploded view of the swivel-type actuator

The swivel-type actuator need not be dismantled when the bowl is to be removed. If, however, the swivel-type actuator has to be dismantled in order to replace a defective component, the bowl has to be removed and reinstalled as shown in Fig. 103.

Also keep in mind the following points:

- The pointer indicating the angle of setting must be on "0".
- Place on the drive pinion as shown in Fig. 103.

5.5 Assembling the feed and discharge connections

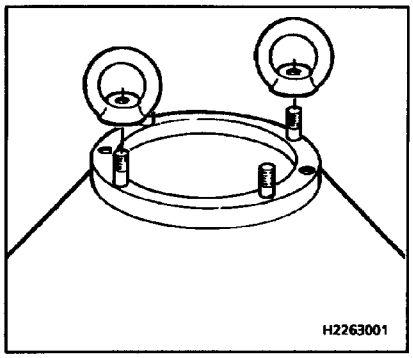


Fig. 104

- Screw two ring nuts opposite each other onto the studs of the hood.

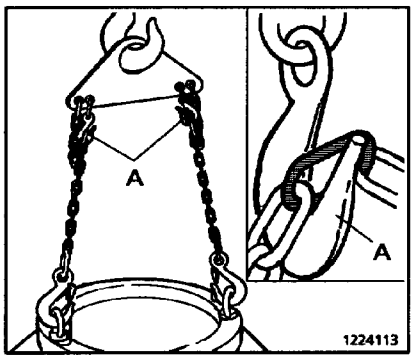


Fig. 105

- Shorten the chains of the lifting device.
  The chain link must be put crosswise on hook A (see adjacent small figure)!
- Hang the shortened lifting device into the lifting-eye nuts and place the hood on the solids collector.
- Bolt hood and solids collector together using hex head screws.

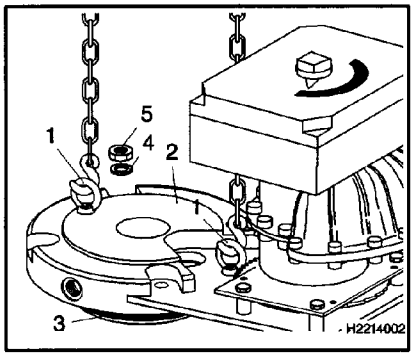


Fig. 106

- Thread two eye bolts 1 into ring 2.
- Insert gasket 3.
- Place on ring 2 together with the swivel-type actuator.
- Fasten ring 2 by means of hex head screws 5 with installed lock washers 4.

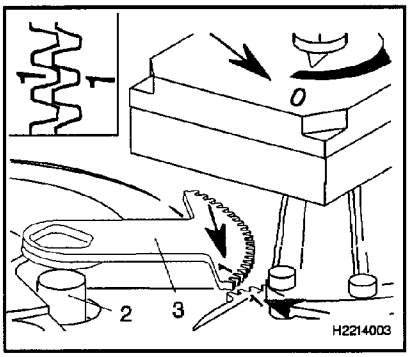


Fig. 107

- The pointer must be on "0" (see arrow).
- Place toothed segment 3 on centripetal pump 2 (watch for "O" mark position).
- Insert toothed segment 3 so that the marks of the teeth of segment 3 and of the drive pinion are placed opposite to each other (see arrows in figure).
  For this purpose, the centripetal pump has to be turned while the toothed segment is to be held in a slightly inclined position.

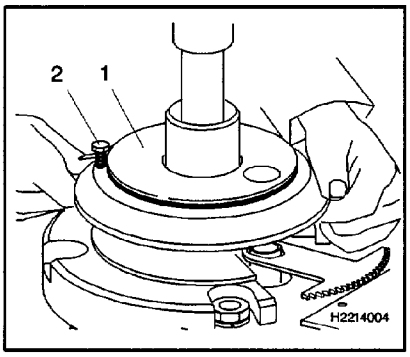


Fig. 108

- Undo screw 2.
- Place on ring 1 with inserted gasket. The ring must be perfectly seated; if it is not, the toothed segment has not been properly fitted.

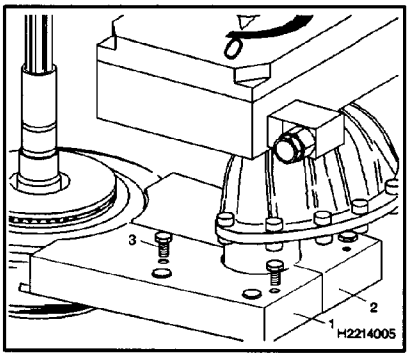


Fig. 109

- Place on protecting-case halves 1 and 2, and fasten them with hex head screws 3.

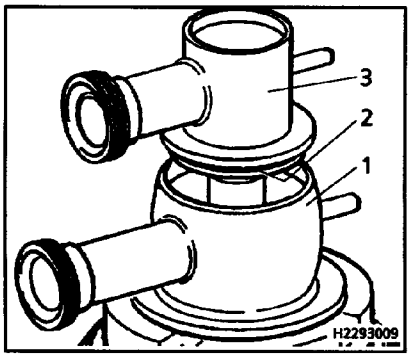


Fig. 110

- Install lower discharge 1.
- Install upper discharge 3 (with inserted gasket 2)

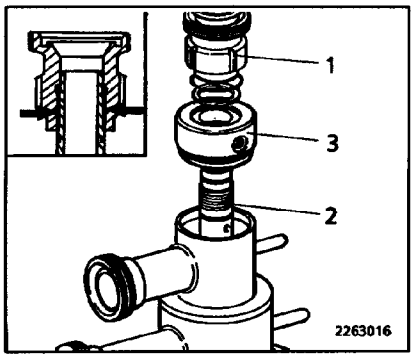


Fig. 111

- Apply a thin film of grease to the threads on feed tube 2 and in connection piece 1.
- Place on vent piece 3 with inserted gaskets.
- Screw connection piece 1 (with inserted gasket) on centripetal pump 2 and tighten firmly.

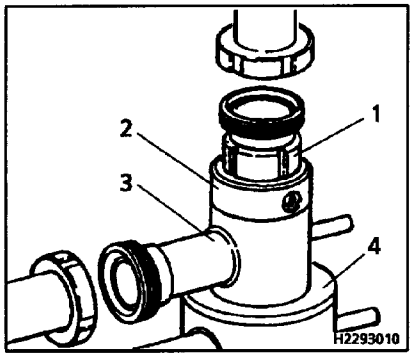


Fig. 112

- Connect the feed and discharge lines.
- Connect the vent line.

- Carry out the electrical connection of the contact pressure gauge.
- Install the sight glass illumination.

Stop

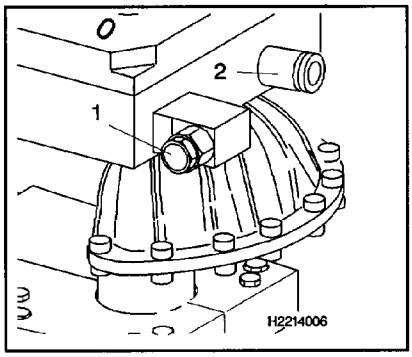


Fig. 113

- Connect current supply 1 and compressed-air supply 2.

Note:
The protecting cases must be in place - danger of crushing!

5.6 Replacing the main bowl gasket (bowl top)

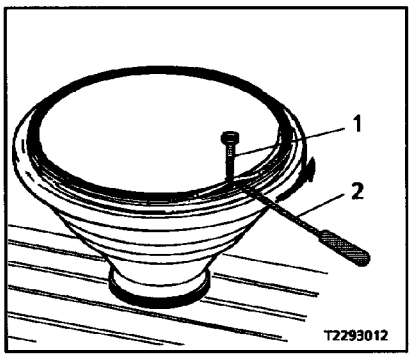


Fig. 114

Removal

- Screw wooden screw 1 into the gasket.
- Lever out the gasket with screwdriver 2.

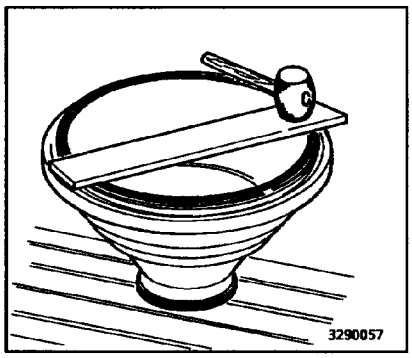


Fig. 115

Fitting

- Insert the gasket in the cleaned groove of the bowl top (with the narrow side towards the bowl top).
- Drive the gasket evenly into the groove.

  If the diameter of the gasket is too small, place it in a water bath of 70 – 80 °C for about 5 minutes. The gasket will then assume its original dimensions.

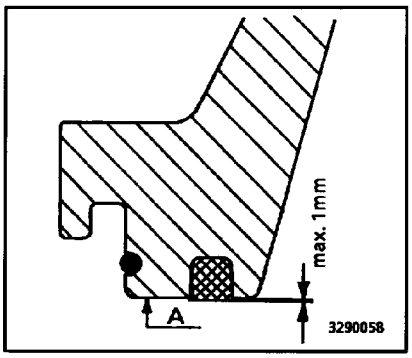


Fig. 116

- Drive the gasket into the groove so far that the sealing area of the gasket does not protrude above surface "A" of the bowl top by more than 1 mm.

5.7 Removing the piston valves

- Remove the piston valves **once a month** for cleaning.
- At the same time, check the gaskets and replace them if necessary.

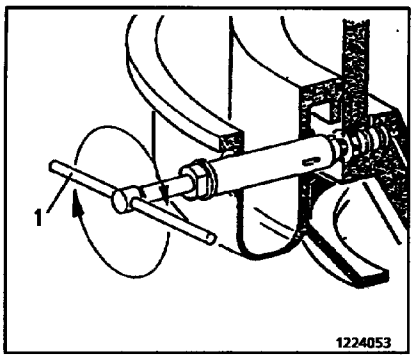


Fig. 117

- Screw wrench 1 into the piston valve.

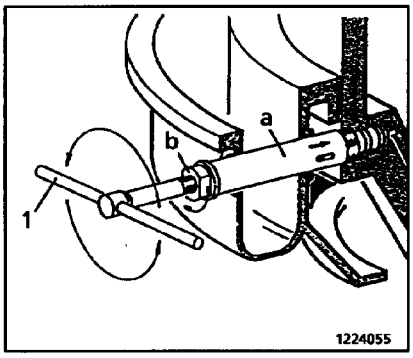


Fig. 118

- Introducepins of bush **a**of wrench 1 into the holes of the piston valve.
- Tighten collar nut **b**.
- Unscrew piston valve from bowl bottom using wrench 1.

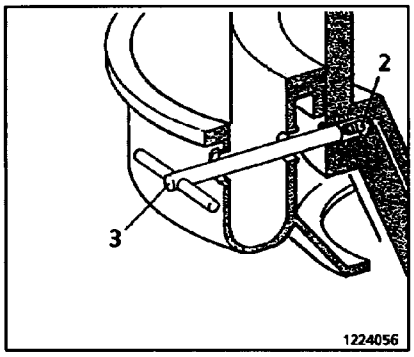


Fig. 119

If valve piston 2 should become stuck in the bowl bottom when removing the valve:

- Screw wrench 3 into the valve piston.
- Remove the valve piston from the bowl bottom using the wrench.

5.8 Fitting the piston valves

For fitting, proceed in reverse order of removal.

NOTE:

- Moisten gaskets.
- Grease threads.
- Screw in the valve as far as it will go. Hoever, do **not** screw it in **too tightly** .
- The front face of the valve housing must be flush with the outer wall of the bowl bottom.

5.9 Disk stack compressing device

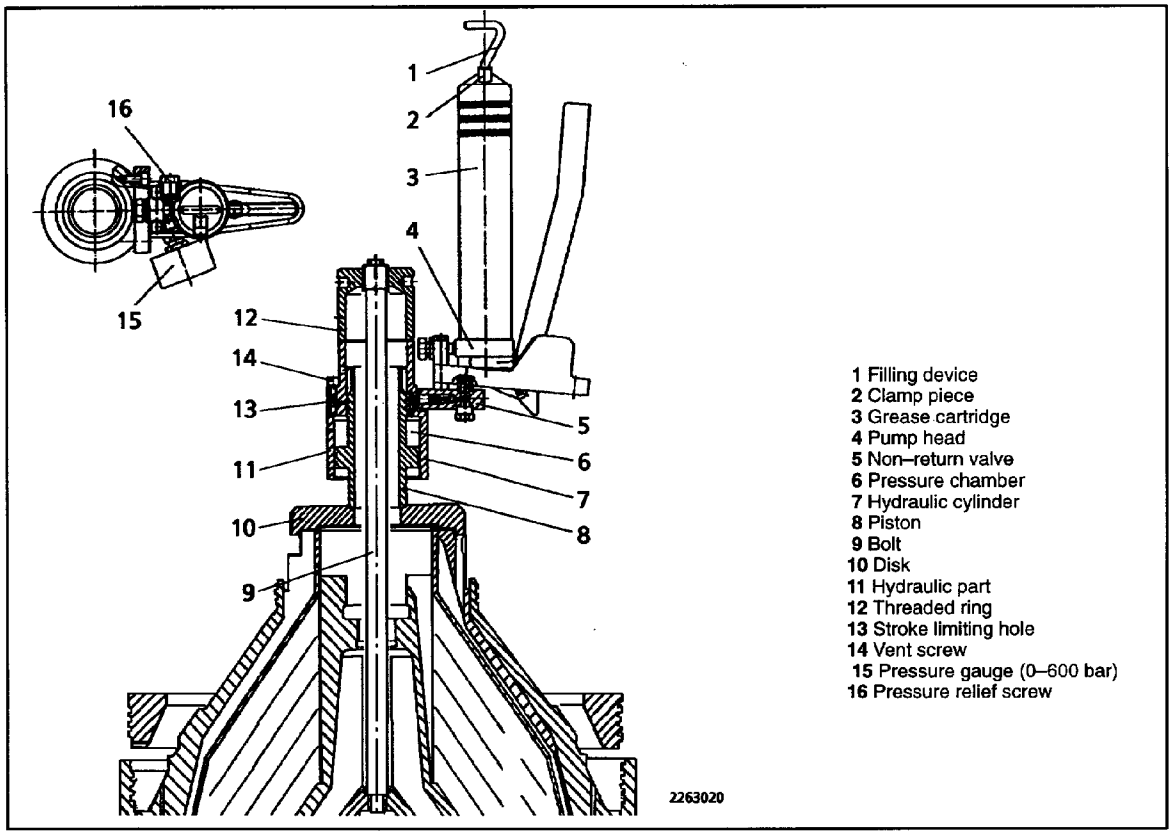


Fig. 120

Operating principles

The pump presses grease at a high pressure into pressure chamber 6.

The increase in pressure in the pressure chamber displaces piston 8 relative to hydraulic cylinder 7.

The hydraulic part 11 (piston, hydraulic cylinder) is bolted securely to the bowl bottom by means of bolt 9 and threaded ring 12.

When the pressure increases in pressure chamber 6, piston 8 is forced downwards.

The force produced is transferred to the bowl top via the disk 10. The disk stack is compressed.

Required pressure:	250 – 300 bar
Max. pressure:	320 bar

Pump

The pump produces a pressure of max. 400 bar. It consists of:

- Pump head
- Grease cartridge
- Filling device
- Non–return valve

Filling the grease cartridge

Filling the grease cartridge: 450 g special grease K2R

The grease cartridge of the compressing device is filled with special grease before delivery.

- Actuate tclamp piece 2 and pull the filling device 1 upwards.
- Unscrew grease cartridge 3 from pump head 4.
- Fill in grease, approx. 450 g.
- Screw grease cartridge 3 into pump head 4.
- Actuate clamp piece 2 and push filling device 1 into grease cartridge 3.



Fill the grease cartridge only with WS special grease K2R.

Malfunction

If there is no build–up of pressure, the following must be checked:

- Is the pressure relief screw 16 screwed in tightly?
- I there enough K2R grease in the grease cartridge?
- Has piston 8 travelled too far out of hydraulic cylinder 7?

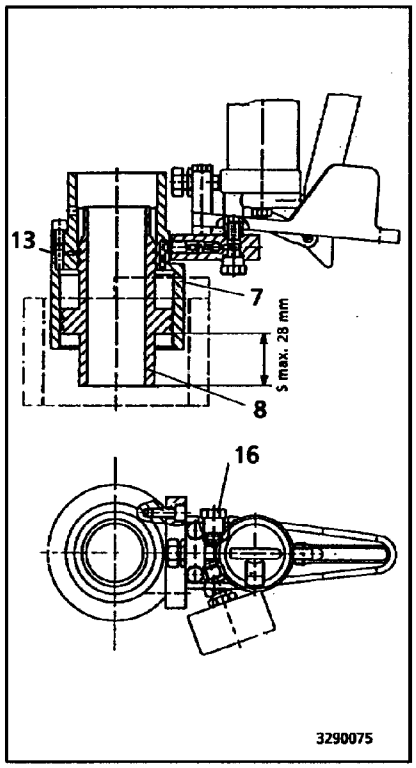


Fig. 121

If this is the case:

- Unscrew pressure relief screw 16 by a few turns.
- Press piston 8 back into hydraulic cylinder 7. This must be done in the absence of pump pressure.
- **Firmly** re–tighten pressure relief screw 16.

7 Hydraulic cylinder
8 Piston
9 Bolt
16 Pressure relief screw

- If grease oozes out through the stroke limiting hole 13, bolt 9 and threaded ring 12 have not been screwed into their fina position, and the stroke is too long.

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6 Technical information

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6.1 Design features

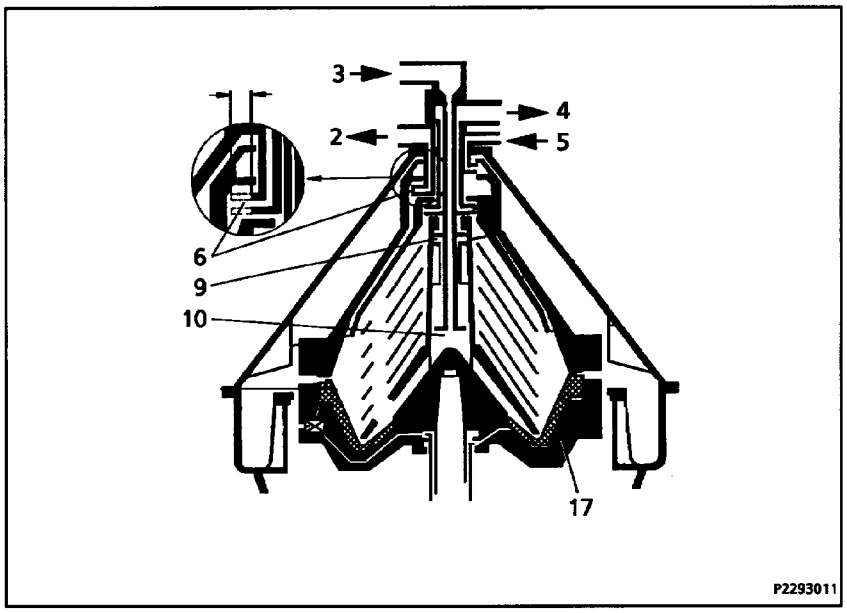


Fig.122

- **Self–cleaning bowl:**
  - The bowl can be emptied during operation by means of a hydraulically actuated piston 17.
- **Closed feed and discharge of the product phases:**
  - The feed is through a closed line system.
  - To observe the product, sight glasses are fitted in feed 3, clean oil discharge 4 and in the discharge of the heavy phase 2.
  - A pressure switch monitors the discharge pressure of the light phase.
  - Soap or gums are discharged through a closed discharge pipe.
- **"Fine Tuner":**
  - With the aid of the "Fine Tuner", the separating zone in the disk stack can be altered while the machine is running. By this means the separator can be optimally adapted to changes in the product (e.g. different oil types).
    In addition the separating zone can be briefly displaced towards the centre during start–up and bowl ejections, thereby preventing oil from flowing over the outer diameter of the separating disk.
- **Hydrohermetic feed:**
  - The product is gently fed through feed 10 into the bowl with a slight overpressure.
- **"Vapour seal":**
  - A hydrohermetic seal 9 prevents the oil from becoming turbid due to contact with vapours from the inlet chamber.

- **"Bowl Flush":**
  - Liquid can be fed into the outer solids space through a separate channel 5.

    By this means surplus caustic or acid can be flushed out or a highly viscous heavy phase can be diluted and more easily discharged from the bowl.

6.2 Operating principles of the bowl

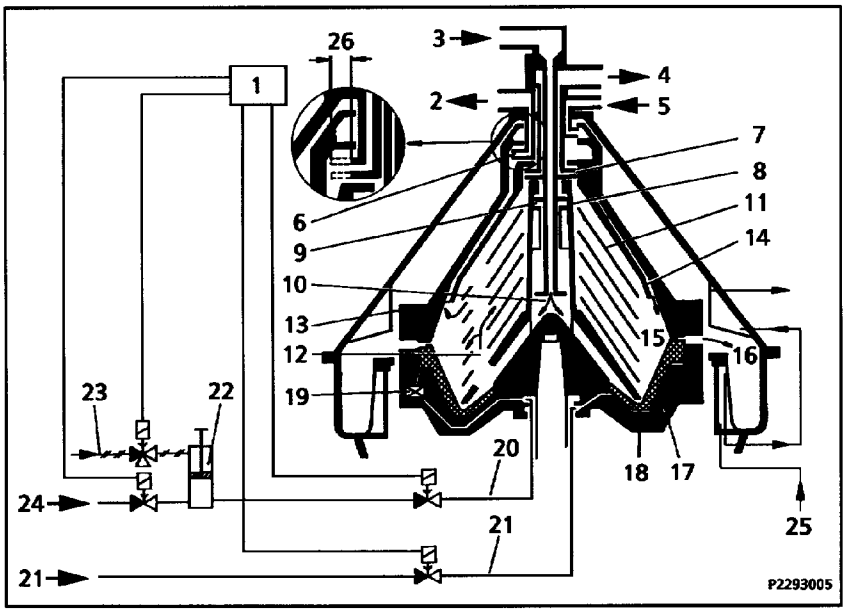


Fig.123

1	Control unit	14	Flush water channel ("Bowl flush")
2	Discharge (heavy phase)	15	Solids holding space
3	Feed	16	Solids ejection ports
4	Discharge (light phase)	17	Sliding piston
5	Flush water connection ("Bowl flush")	18	Closing chamber
6	Centripetal pump – heavy component (fine tuner)	19	Piston valve
7	Centripetal pump – light component	20	Opening–water
8	Distributor	21	Closing–water
9	"Vapour seal"	22	Metering piston
10	Hydrohermetic feed"	23	Control air
11	Disc stack	24	Filling water / opening water
12	Rising channels	25	Cooling medium
13	Separating disk channels		

- The bowl is applied for the separation of mixtures which consist of
  - a liquid (oil) and
  - pasty substances (soapstock or gums), with simultaneous separation of the solids contained in the mixture.

The product

- flows through feed 3 into the bowl,
- is clarified in disk stack 11.

The disk stack consists of a large number of conical disks placed on top of one another.

Due to the narrow disk interspaces

- the liquid is split up into thin layers,
- the settling distance is minimised.

The light component

- is forced to the centre of the bowl,
- then flows to the centripetal pump chamber cover,
- is discharged under pressure by centripetal pump 7,
- is then led off through the discharge pipe 4.

The heavy component

- is forced towards the bowl periphery,
- then flows to the centripetal pump chamber cover,
- is discharged under pressure by centripetal pump 6,
- and then led off under gravity through a discharge pipe.

The solids particles

- are flung against the underside of the disk above,
- slide towards the periphery into the solids space 15,
- and are periodically ejected through the solids ejection ports 16.

The solids ejection is initiated by the control unit 1.

6.3 Operating principles of the hydraulic system of the bowl

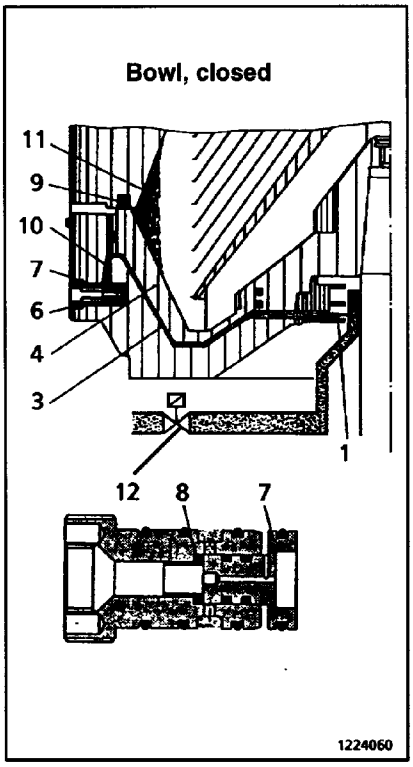


Fig. 124

Closing the bowl

When the bowl has reached its rated speed, solenoid valve 12 for closing water is opened briefly several times. The closing water flows into the closing chamber 3 beneath the sliding piston 4.

Due to the rotation, pressure builds up in the closing chamber. This pressure creates force in axial direction which presses the sliding piston against gasket 9 of bowl top, thus closing the solids holding space 11 during the separation process.

Closing chamber 3 is sealed by valve piston 7 which is pressed through centrifugal force against gasket 8 and thus closes discharge hole 10.

In order to compensate for closing water losses, closing water and filling water are supplied every 5 mins for 1sec via an interval switching arrangement.

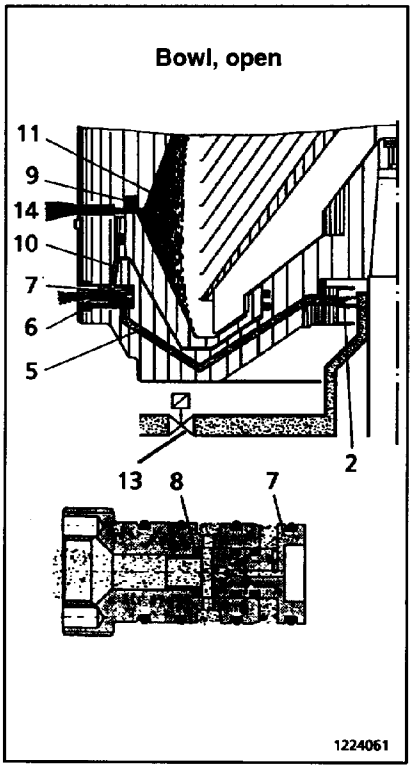


Fig. 125

Opening the bowl (ejection)

To empty the solids holding space opening water 13 is added which flows from injection chamber 2 through feed hole 5 to piston valve 6. Due to hydraulic opening of the valve the water discharges from the closing chamber through hole 10:
for partial ejection the closing chamber empties partially,
for total ejection it empties completely.

As the liquid level recedes the closing pressure acting on the underside of the sliding piston decreases quickly. As soon as it is smaller than the opening pressure acting on the upper side of the piston, the sliding piston is pressed downwards, thus opening the ejection ports in the bowl bottom: the solids are then ejected instantaneously through the ejection ports 14 of the bowl.

Once the ejection has taken place,

- opening-water valve 13 closes
- closing-water valve 12 opens.

Piston valve 6 re-seals discharge hole 10 and the closing chamber fills with water again. The sliding piston is forced back into closed position.

6.4 Operating–water connection

The operating–water connection is equipped with solenoid valves, pressure reducer and pressure switch.

The function of the pressure switch is to monitor the operating–water pressure. If the pressure drops below a preset minimum value, an alarm is given and the separation program interrupted.

Operating–water connection:	1 1/4 in	
Operating–water pressure (with open closing–water valve)	$P_{min.}$ =	2,0 bar
	$P_{max.}$ =	2,5 bar
Operating–water capacity:	=	4 000 l/h
Air pressure for metering unit:	$P_{min.}$ =	4 bar
	$P_{max.}$ =	6 bar

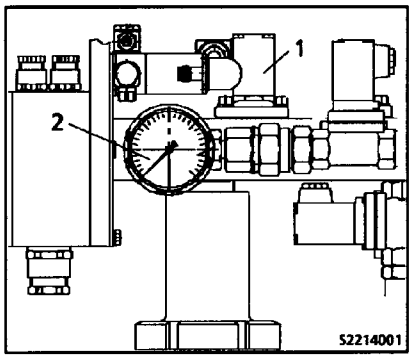


Fig. 126

Note:

Prior to a partial ejection there is a brief water pressure increase in the operating–water connection. This can be read off on pressure gauge 2.

Adjust the air pressure for the metering unit so that the heightened water pressure is lower than the maximum pressure marked on solenoid valve 1.

- If the setting is wrong no partial ejection is possible.

Standard operating–water values:

- Suspended material in operating water — max 10 mg/l
- Particle size: — max. 50 µm
- Hardness: ≤ 12 °dH separating temperatures of up to 55°C
  ≤ 6 °dH at separating temperatures above 55°C
  To convert the hardness values stated use the following equation:
  1°dH = 1,79°fH = 1,25°eH = 17,9 ppm $CaCO_3$
- Chlorine ions: ≤ 100 mg/l
- pH–value: 6,5 – 7.5

6.4.1 Solenoid valves

The solenoid valves incorporated in the operating–water system are 2/2–way straight–way diaphragm valves with internal piloting.
The solenoid coil is entirely embedded in epoxy resin which ensures protection against moisture, good dissipation of heat, and perfect electrical insulation.
The valves are fully tropicalized.

Maintanance

The solenoid valves do not require special maintenance.

Electrical faults

- Shut off main valve for operating–water.

Fault	Cause	Remedies
Valve does not function.	Control unit defective.	Contact servicing staff.
	Connecting terminal on terminal strip is loose.	Tighten screw of connecting terminal.
	Coupler socket loose or leaks.	Tighten coupler socket and replace gasket, if necessary.
	Solenoid coil defective.	Replace complete solenoid head.

6.5 Swivel-type actuator for control of the centripetal pump

The swivel-type actuator is controlled by means of an electric unit signal. As auxiliary anergy, instrument air (dry and free of dust) is required.

Air pressure: P_{min} = 4bar
P_{max} = 6 bar

Flow rate: approx. 47 Nl/min

- The centripetal-pump diameters required
  a) for operation (≅ large diameter) and
  b) for start-up / partial ejection (≅ small diameter) are entered on the control unit.

  The values entered are transformed to a certain electric signal. This signal causes the centripetal pump to enter into the desired position. The actual position can be read from the separator.

7 Operation

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7.1 Prior to start-up

- **Note:**
  - Instruction manual of the respective control unit.
  - Safety precautions in chapter **1**.
  - Subject to process-specific deviations.
  - Only feed product which conforms to the specifications on the nameplate.
- **Check that**
  - the machine has been correctly installed.
  - the bowl is fitted.
  - the bowl lock rings have been tightened securely.
  - the fastening screws on the hood and on the feed and discharge housing are tightened securely.
  - the mechanical brake is applied.
  - the frame drains are open.
  - the oil level is up to middle of sight glass.
  - all electrical connections are duly installed.
- Open hand shut-off valves in the supply lines for:
  - operating-water,
  - compressed air
- Set the air pressure on the pressure reducer for the metering cylinder to 4–5 bar.
- Set the air pressure on the pressure reducer for the swivel-type actuator to 4–6 bar.

7.2 Starting

- Switch on main switch on control unit (position **I**):

The LED "control unit ON" flashes to signal that the control unit is ready for operation.
The buttons "product", "partial ejection" and "total ejection" are not released until the signal "motor in operation" is on (see LED in motor mimic diagram).

- Start motor.
  After a pre–set delay time of 10 minutes, closing water is supplied automatically; the bowl closes.
- After a further 2 minutes the bowl can be heated up with water.
- Switch–over from water to product.

7.3 Closing of bowl:

After having switched over from acceleration to operation, two total ejections are carried out automatically in order to close the bowl. Unless this program has been activated, the two total ejections have to be initiated manually by pressing the corresponding function key.

To prevent water losses, closing water is injected every 5 minutes for one second.

All program time settings are variable.

Closing–water injection is indicated by an LED in the separator symbol on the timing unit.

7.4 Water run after start–up

- Check if
  - metering unit is adjusted on the operating–water connection.
  - program times are adjusted on the control unit in accordance with the operating conditions (see section 7.5.3 and IM Control Unit).
- Feed water to separator.
- Check the bowl for leakage:
  - Bowl leakage is shown by an increase in the power consumption of the motor which is indicated on the ammeter.
  - In case of bowl leakage,
- stop water run,
- operate key „Total ejection".
  - Re–fill bowl with water and check again if bowl is watertight.
  - If the bowl cannot be closed after several trials,
- operate „Total ejection" key.
- let bowl run warm **for max. 15 minutes without supplying water.**
  While doing so, the polyamid gasket in the groove will adapt to the sealing surface of the sliding piston.
  - Then fill the bowl with water again and check if it is watertight.
  - If the bowl is still leaky,
- shut down the separator via „Normal Off".
- dismantle the bowl **after standstill** and check polyamid gasket, gaskets of the hydraulic system, etc.
- The ejection process is indicated by LEDs in the valve symbols on the mimic display.

7.5 Bowl ejection

When to empty the bowl?

The intervals at which solids ejections have to take place depend on the solids content and on the nature of the process liquid.

If possible, the solids holding space should not be filled to the brim.

As soon as the separating or clarifying efficiency decreases, a partial ejection has to be triggered.

7.5.1 Program control

A PLC control unit is used for the automatic program control of the separator.

For further details refer to the manual "Control unit".

7.5.2 Partial ejection

Partial ejection means the ejection of part of the solids from the bowl. Product feed is not interrupted during partial ejection.

To prevent any carry-over, the "Fine Tuner" is contracted before a partial ejection and is extended to its normal operating position once the partial ejection is finished. This operation is initiated by the control unit (see functional diagram, 7.5.3).

The volume to be ejected can be set during operation.

For partial ejection, opening water is fed to the hydraulic system via the metering device.

The amount of solids to be ejected is primarily determined by the opening water volume. This volume is set on the metering device.

To determine the volume of solids ejected, fill the bowl with water and measure the volume of ejected water.

The quantity of ejected material can easily be determined by means of the feed rate and of the pressure reduction occurred the light-phase discharge line.

Check the quantity of solids ejected in a partial ejection during normal operation or during operation with water, proceeding as follows:

Example: Feed rate: 18,000 l/h

Pressure reduction:approx. 1.4 sec.

Flow rate per second: 18,000 l/h : 3,600 s/h = 5 l/s

5 l/s x 1.4 s = 7 l.

This means that it will take 1.4 seconds until the bowl is filled up again. During this period, 7 liters of liquid flow into the bowl. This quantity corresponds to the amount of liquid that was ejected from the bowl during partial ejection.

Setting the volume to be ejected:

Use the adjusting screw on the metering device.

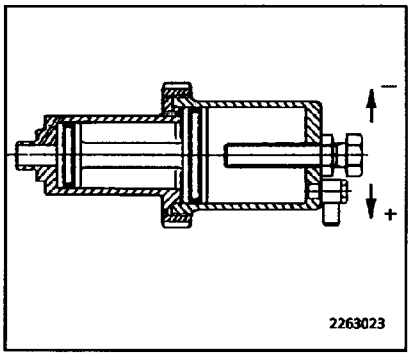


Fig. 127

- Reduce ejection volume.
  - **Open** the opening-water valve to displace the water which cannot be compressed from the bowl. Otherwise the increase in pressure would destroy the pressure gauge and the piston rod.
  - Turn adjusting screw clockwise
  - Close the opening-water valve.
- Increase ejection volume:
  - Turn adjusting screw anti-clockwise.

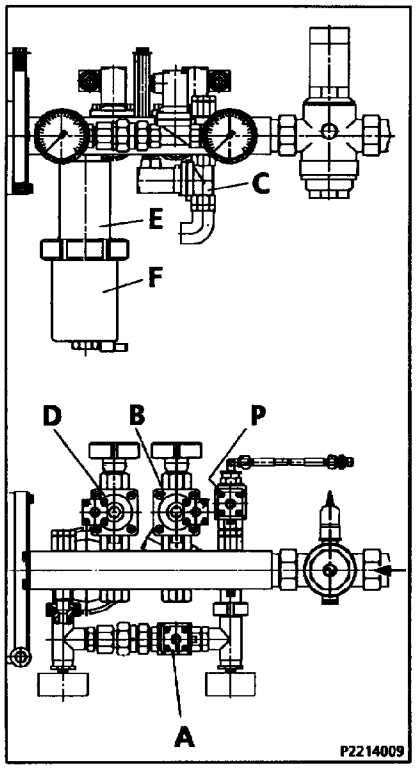


Fig. 128

Function of the metering device

The metering device E is filled with water via filling valve A after each solids ejection.

For partial ejection chamber F is supplied with compressed air.

Through actuating the opening water valve D the adjusted water volume is displaced by air pressure and fed to the hydraulic system of the bowl.

A Solenoid valve for filling water
B Solenoid valve for closing-water
C Solenoid valve for hood flush water
D Solenoid valve for opening-water
E Metering device
F Air chamber
P Solenoid valve for cooling water

Program sequence

Also refer to section 7.5.3

After the program time "Separation - Partial Ejection" has elapsed, a partial ejection is initiated automatically which is then repeated at identical intervals.

Before each partial ejection the solenoid valve C "Hood flush water" opens for 10 approx. seconds. This time can be preset as the program time "Pre-flushing". Water is sprayed into the hood to prevent the solids to be ejected from sticking to the walls.

For solids ejection the solenoid valves B "Closing water" and D "Opening water" open for 1 second. This time can be preset as the program time "Partial ejection".

The solenoid valve B "Closing water" remains open for a further 5 seconds after the ejection. The time is set via "Closing". At the same time the hood flush water valve stays open for the time "Post-flushing".

The "Separation" program can be interrupted by pressing the "Partial ejection" button. A partial ejection is then triggered. After termination of this forced partial ejection the control program automatically switches back to "Separation".

Before each partial ejection, the "Fine Tuner" is set to a small centripetal-pump diameter (see 7.5.3-"Ta").

After each ejection, the centripetal pump is reset to its large diameter as soon as the pre-set waiting period is elapsed (see 7.5.3 - "Tb").

These periods are adjustable.

Adjusting the program times:
Program times... **secs** are process-related and must be set before start-up.

Program time	
Pre-flushing	approx. 10 secs Pre-flushing of hood/solids collector
Partial ejection	1 secs This determines the opening time of the opening-water valve. This time must be longer than the displacement time of the opening water from the metering unit. The ejected solids volume depends on the preset volume in the metering unit.
Secondary flushing	approx. 20 secs Flushing the hood and solids collector after an ejection
Closing	5 secs Addition of closing water after an ejection
Metering device	3 secs Continued control of air for metering device after partial ejection.
Filling water	2 secs Delayed filling water supply after partial ejection.
Total ejection	10 secs (not variable) Addition of opening water during total ejection.
Waiting	approx. 60 secs Waiting time after total ejection for speed recovery of bowl.
Delay of ejection after contracting the centripetal pump (Ta)	depending of throughput [1)] Displacing the separating zone inwards, in order to get more heavy phase into the bowl
Delay in extending the centripetal pump after ejection (Tb)	depending on throughput [1)] Filling up the bowl with heavy phase
Delay in extending the centripetal pump (Tc)	depending on throughput [1)] When starting with product, the bowl must be filled with heavy phase until no carry-over will occur when the centripetal pump is extended.

1) the higher the throughput, the shorter must be the time

7.5.3 Function diagram of partial ejection

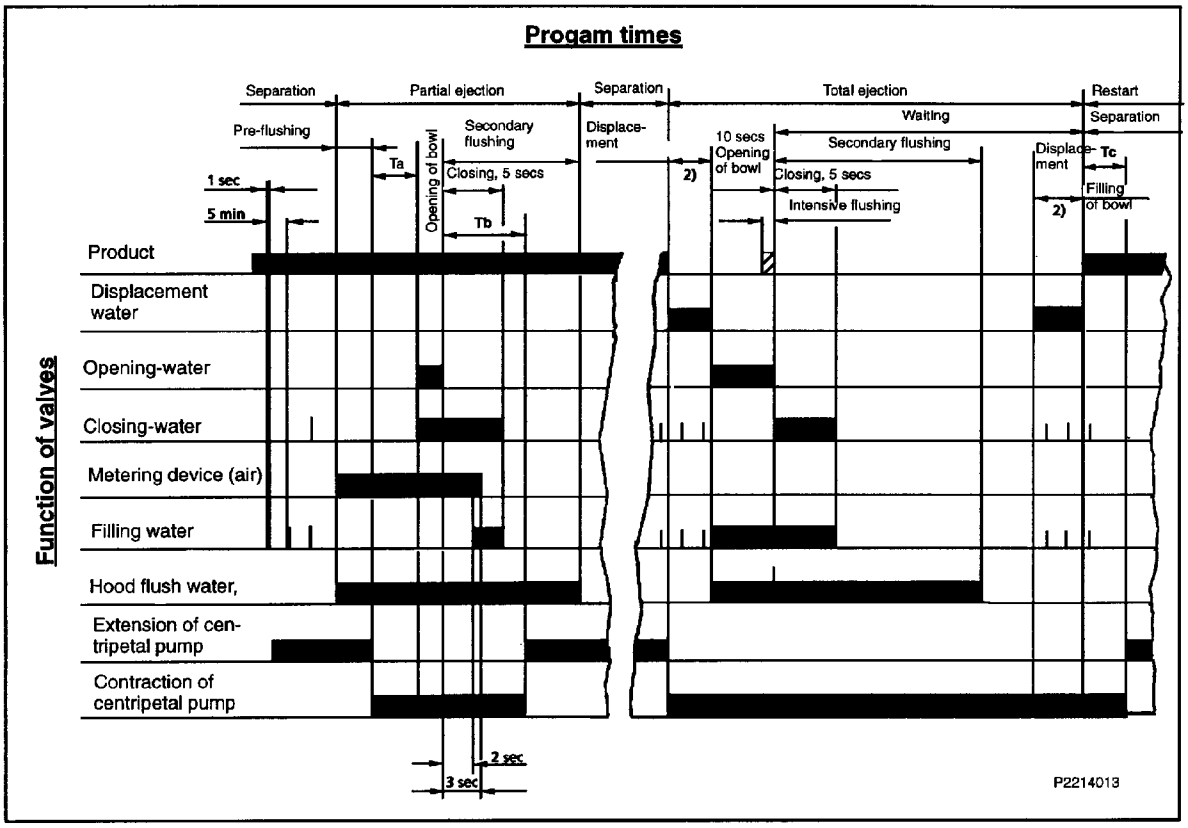


Fig. 129

Setting the program times: See control unit manual

1) When the waiting period for resuming the bowl speed has elapsed, no automatic switch-over to "separation" will take place.
2) These functions are provided in the control unit and can be adjusted if an automatic water valve has been installed.

Ta Delay of ejection after contracting the centripetal pump)

Tb Delay in extending the centripetal pump after ejection

Tc Delay in extension of centripetal pump (after starting with product).

7.5.4 Total ejection

Total ejections during cleaning-in-place can only be performed by hand on the control unit. (Automatic Ceaning-In-Place is only possible with a separate CIP control system, see corresponding leaflet.)

During a total ejection the whole bowl contents are ejected.



Never initiate a total bowl ejection when the machine is vibrating severely (bowl unbalance).

To trigger a total ejection, press function key "Total ejection".

If installation has been carried out correctly (see connection diagram of control unit) the feed pump is automatically switched off when the "Total ejection" key is pressed and starts again automatically about 1 minute after the total ejection.
Interrupting the feed to the bowl by switching off the feed pump is necessary so that the bowl speed, which drops slightly during a total ejection, can stabilize again.

After renewed filling of the bowl (observe increasing discharge pressure on separator) a further total ejection can be triggered by again pressing the "Total ejection" key.

If the feed pump is not automatically switched off during a total ejection, switch it off by hand and switch it on again 1 minute after the total ejection.

7.5.5 Bowl ejections (manual)

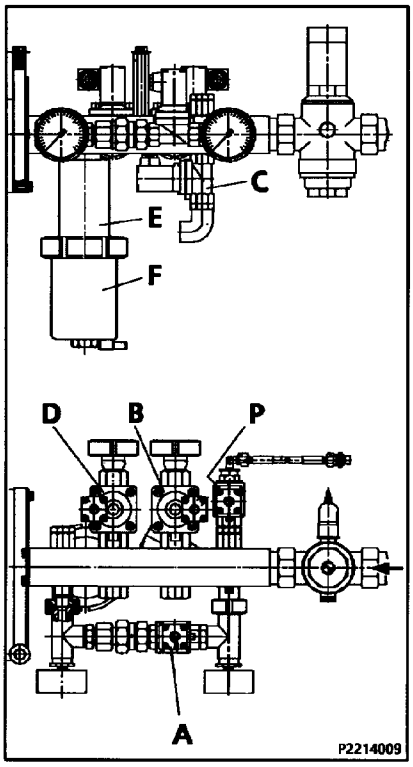


Fig. 130

In the case of failure of the control unit or defective solenoid valves, the separator can be manually controlled as follows:

Partial ejection

- Open closing–water valve B and fill–up valve A manually by means of hand lever.
- Open opening–water valve D briefly (approx. 1 sec.).
- After partial ejection leave closing–water valve B open.

Total ejection

- Stop product pump.
- Open closing–water valve B and fill–up valve A manually by means of hand lever.
- Open opening–water valve D by means of hand lever until the ejection noise has stopped.
- Then close opening–water valve D and fill–up valve A; leave closing–water valve B open.
- Re–start product pump 1 minute after total ejection.

7.6 Adjusting the separation efficiency

To achieve perfect separation of the liquid mixture, the bowl must be adjusted to the different densities.

- To do this,
  - first adjust the "Fine Tuner" (7.6.1)
  - and then the hydrohermetic feed system (7.6.4).
  - Then carry out final adjustment of the "Fine Tuning" (7.6.5).

7.6.1 Adjusting the "Fine Tuner"

The bowl is adjusted to the different densities of the mixture by altering the diameter of the "Fine Tuner".

The required diameter of the "Fine Tuner" can be determined using the formula below.

The general rule of thumb is:

- Small "Fine Tuner" diameter with a low density difference,
- Large "Fine Tuner" diameter with a large density difference.

When separating pasty substances, the diameter of the "Fine Tuner" not only depends on the densities of the two components but also on the flow characteristics of the heavy component.
In almost all cases a larger diameter of the "Fine Tuner" should be selected than is actually required by the difference in densities of the light liquid and the heavy pasty component.

7.6.2 Determining the "Fine Tuner" by calculation

The formula below can be used to calculate the diameter of the "Fine Tuner". Bear in mind that the densities depend on the temperature. When determining the diameter of the "Fine Tuner", those densities must be entered which correspond to the separating temperature.

$\gamma_{heavy\ phase} = 1.0484\ kg/dm^3$ $D_{oil\text{-}centrip.\ p} = 110\ mm$ (immersed)

$\gamma_{oil} = 0.88\ kg/dm^3$ $D_{separating\ zone} = 412\ mm$ (middle of rising channnel)

$$\gamma_{heavy\ phase}\,(D_{sep.\ zone}^2 - D_{heavy\ phase}^2) = \gamma_{oil}\,(D_{sep.\ zone}^2 - D_{oil}^2)$$

Therefore $D_{heavy\ phase}$ is determined by the following formula:

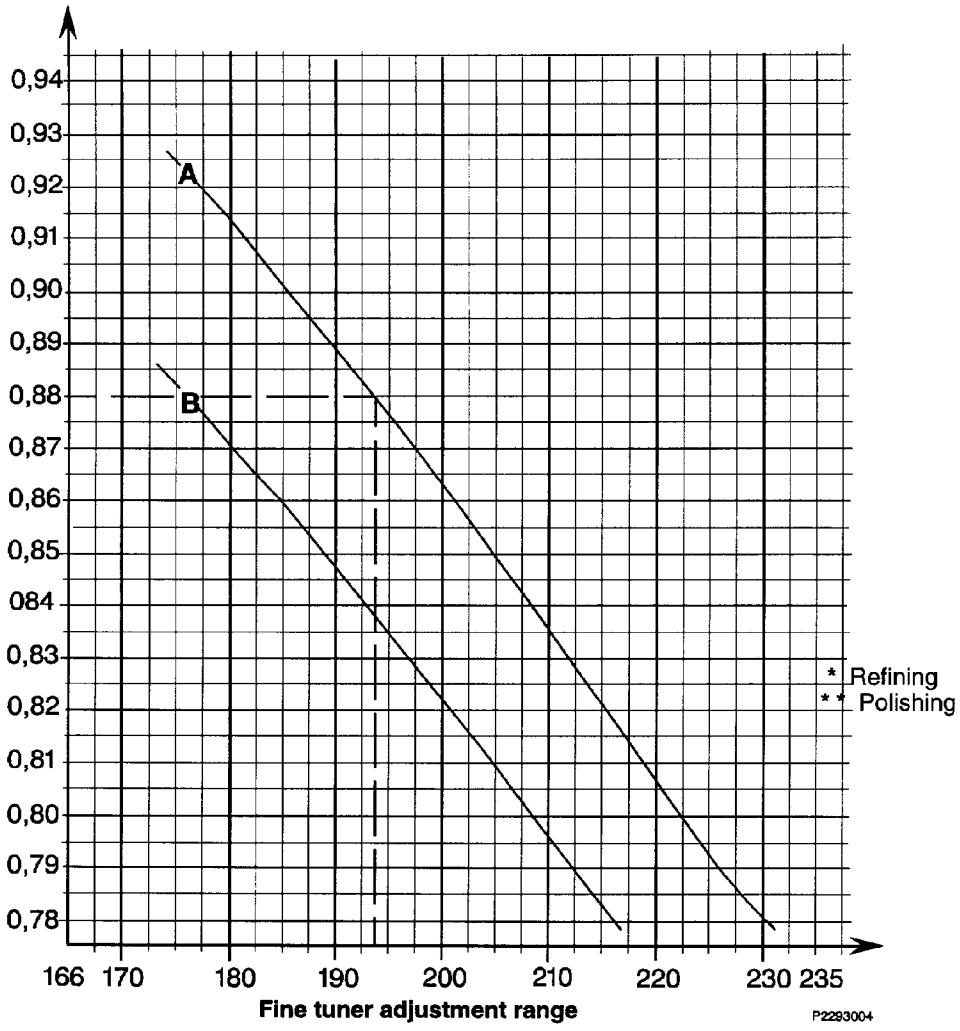
$$D_{heavy\ phase} = \sqrt{D_{sep.\ zone}^2 - \frac{\gamma_{Oil}}{\gamma_{heavy\ phase}} \cdot (D_{sep.\ zone}^2 - D_{oil\text{-}centrip.\ pump}^2)}$$

From the position of the separation zone which forms in the bowl between the light and heavy liquid you will be able to judge whether the proper diameter of the "Fine Tuner" has been selected. The middle of the separation zone is the separation line which can almost always be seen on the underside of the discs after opening the bowl. It is sufficient to check a few of the upper discs.

The separation line should pass through the outer third of the disc holes (rising channels).

A: γ_S= 1, 0484 kg/m^3

B: γ_S= 1, 00 kg/m^3



Example

To be determined: Diameter of the "Fine Tuner"

Given: γ_{oil}= 0.88 kg/dm^3

Determined: for refining: 194 mm

Fig.131

7.6.3 Preliminary adjustment

Adjustment of the separating efficiency of the machine is done by entering the desired centripetal-pump diameter on the control unit.

First select a diameter that is smaller than the required one. This will provide more security against carry-over when the hydrohermetic feed is being adjusted.

Possible adjustments:

- Entering the large diameter: max. 235 mm
  - Thus, the working diameter of the "Fine Tuner" is set (calculated as per 7.6.2), which means that this setting will be used during separation.
- Entering the small diameter: min. 166 mm.
  - Thus, the position into which the "Fine Tuner" will be brought during start-up and ejection is determined.
    A diameter of approx. 180 mm should be taken for reference.

7.6.4 Adjusting the hydrohermetic feed

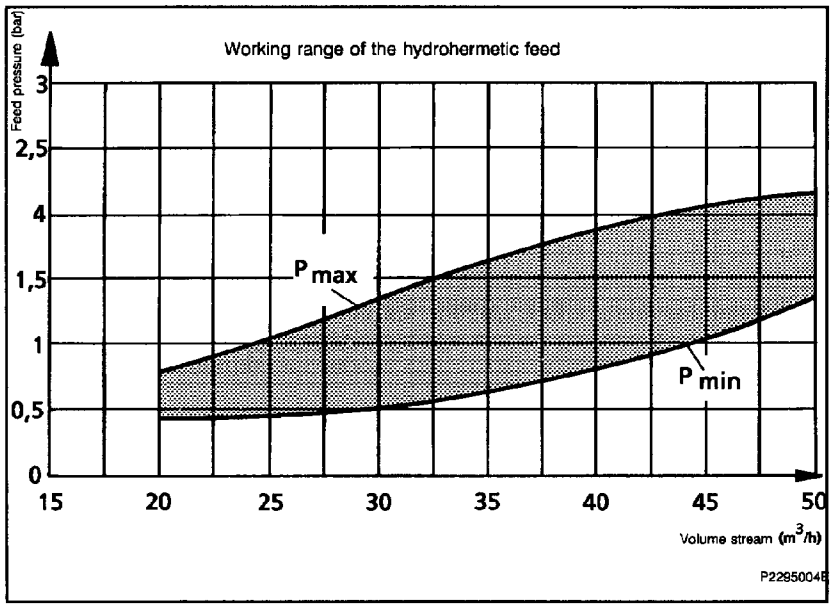


Fig. 132

The values shown in the diagram are based on measuremens with turbine oil and water. They should be considered as reference only. When treating other products, the range of operation might be different.

- Determine feed capacity.
- Determine feed pressure from the above diagram.
- Adjust the determined feed pressure by throttling the light-phase (oil) discharge.

Note:

- If the feed pressure exceeds the permissible value P_{max}, there will be an overflow into the heavy phase.
- if the pressure falls below P_{min}, the system is not sufficiently filled, the hydrohermetic feed does not work.

7.6.5 Final adjustment of separating efficiency

- After having finally adjusted the hydrohermetic feed, carry out final adjustment of the "Fine Tuner".
- Set the optimum separating effect by entering the large centripetal-pump diameter.

- The light phase contains part of the heavy phase.	⇒ Increase the Diameter of the "Fine Tuner".
- The heavy phase contains part of the light phase.	⇒ Reduce the diameter of the "Fine Tuner" or check the discharge pressure to make sure that no overflow from light to heavy phase has occurred.

Note:



- The light-phase centripetal pump is only needed for adjusting the hydrohermetic feed.
  - The hyrohermetic feed is throughput-dependent, i.e. it has to be readjusted when as soon as the throughput changes (7.6.4).
- The "Fine Tuner" is intended for setting the separating zone.

7.7 Product run

- **Prior to feeding oil, supply cold or hot water to the bowl, depending on process conditions,** until the separating temperature is reached (this is of particular importance when treating oils that tend to emulsify).
- Then stop process water supply.
  The water forms a water seal in the bowl which prevents the oil from discharging through the water outlet.
- Open the hand shut-off valve in the product feed line, if provided.
- Press „Product ON" key:
  - Switch on the separation program.
  - Oil metering pump on or product valve open.
- Adjust the throughput capacity.
  - The "Fine Tuner" is positioned for a small centripetal-pump diameter. Carry-over is thus prevented.
    As soon as enough heavy phase has formed inside the bowl, the centripetal pump is positioned for a large diameter. The period to be provided for this step can be preset (see 7.5.3).
- Throttle the pressure in the oil discharge line so that the hydrohermetic feed will work (7.6.4).
- Carry out final adjustment of the "Fine tuner" (7.6.5).

  After the pressure switch on the clean oil side has responded the LED „PAL" goes out. Monitoring of the clean oil discharge is disabled for the program time „delay discharge pressure". The program time starts with „Separation".

  If the pressure switch responds during separation the product feed valve closes automatically or the oil metering pump is switched off and the separation program is interrupted.
  The LED „PAL" flashes.
  Be sure to feed process water again before restarting with product.

  The **throughput capacity of the separator** (i.e. supplied liquid volume per unit of time) depends on

- the viscosity,
- the temperature,
- the difference in densities of the liquid components to be separated,
- the nature of the heavy component to be separated,
- the desired degree of purity of the light component.

- In the case of longer interruptions in operation, e.g. due to no product supply, we recommend carrying out one or two partial ejections by pressing the „Partial ejection" key to avoid compacting of the heavy phase in the bowl.



- The bowl must not run for longer than 15 minutes without liquid supply as otherwise the bowl material could heat up to an unpermissible degree.

The separation program including the partial ejections is carried out automatically by the control unit.

The running program can be interrupted by pressing the „Partial ejection" key which triggers a bowl ejection immediately.

The function diagram shows the program sequence for partial and total ejections.

The program sequence is indicated in the mimic diagram of the control unit by means of LEDs.

7.8 Shutting down the separator

- Flush the installation with water:
  - Close product feed or stop product pump,
  - displace the product contained in the bowl with water.
  - Carry out a total ejection by actuating the "Total ejection" key on the control unit.
  - In case of imbalance close the bowl and shut down the separator with bowl filled.
  - Flush the installation thoroughly with water.
- Switch off the motor.



- The bowl can be braked mechanically.
- **Do not loosen any part before the bowl has come to a standstill!**
- The bowl has not stopped rotating until
  - the gear sight glass looks clear and the worm wheel has ceased rotating, or,
  - the revolution indicator, if provided, has stopped moving.

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8 Cleaning

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8.1 Cleaning-in-place

After use, the Separator must be cleaned in place.
During CIP cleaning solution is circulated through the system.

Attention!

Make sure that the cleaning solution emerging from the discharge lines of the separator cannot be lead into the product lines.

- Set changeover valves, if provided, accordingly.
- If no changeover valves are provided, the plant has to be set up accordingly.

- **For this purpose, proceed as follows:**
  - Switch off the separator and secure it against restart,
  - make sure that all pipelines are **absolutely empty,**
  - Close the valves in the feed and discharge.

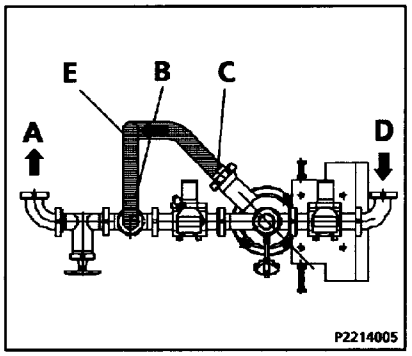


Fig. 133

- Disconnect discharge C.
- Remove the blind nut in discharge B.
- Install pipeline E.
- Remove product feed line D and connect the CIP feed line instead.
- Remove product discharge line D and connect the CIP discharge line instead.
- Arrange the frame drain and the solids collector outlet so as to prevent CIP liquid from flowing into the product tank or the sewer.

- Switch control unit to CIP mode:
  - The separation program is not in operation.

To prevent corrosion damage, only approved detergents should be used.

Example:	Henkel	- 2 % caustic (P3 Super LA)
	Bayer	- 2 % caustic (Trosilin M alkaline)
		- Acid solution 0.5% (Trosilin M acid)

The following cleaning program is recommended:

Program sequence	Duration of the individual program steps
1. **Pre-rinsing** Feed volume:approx. 5 m^3/h Displacing the approx. with hot water	2 - 5 minutes
2. **Flushing with caustic** **Temperature: 70 - 80** °C Feed volume: approx. 5 m^3/h 2% caustic soda (NaOH) (chloride-free) Dissolving the residual sludge Emptying the pipeline with water Total ejection	20 minutes
3. **Flushing with caustic** **Temperature: 70 - 80** °C Feed volume: approx. 5 m^3/h 2% caustic soda (NaOH) (chloride-free) Dissolving the residual sludge Emptying the pipeline with water Total ejection	20 minutes
4. **Intermediate flushing** **Temperature: 70 - 80** °C Feed volume: approx. 5 m^3/h Hot water Total ejection	2 - 5 minutes
5. **Neutralization** **Temperature 65** °C Feed volume: approx. 5 m^3/h Neutralization with 0,5 % HNO_3 solution Emptying the pipeline with water Total ejection	20 minutes
6. **Subsequent flushing** **Temperature: 70 - 80** °C Feed volume: approx. 5 m^3/h Displacing the HNO_3 solution with water Total ejection	5 minutes approx. 30 seconds

The total ejections must be initiated by pressing a button.

The commands „Total ejection" can be automatically triggered from an external CIP control unit.

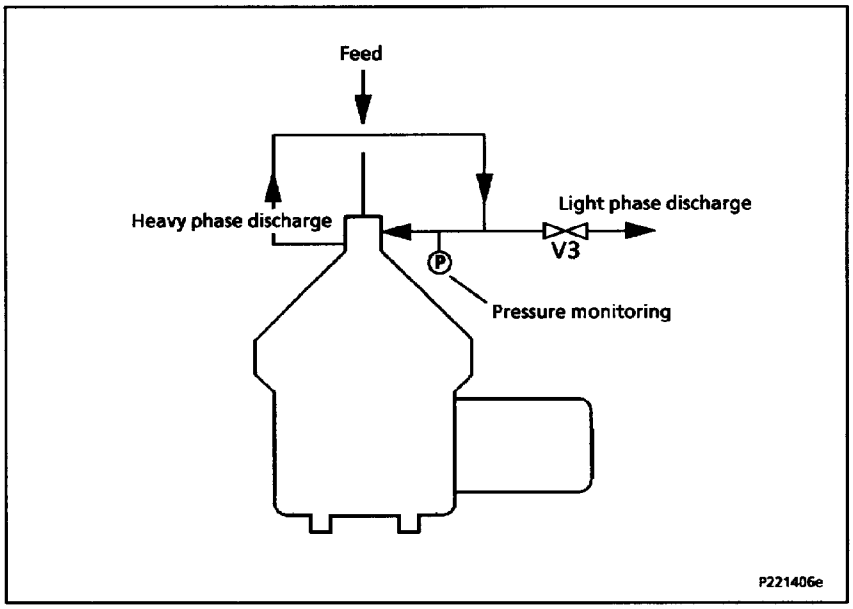


Fig. 134

To obtain perfect cleaning of the bowl, the system has to be connected as follows:

- The CIP solution is led into the feed.
- The liquid emerging from the heavy-phase discharge is diverted into the oil discharge. Thus, an internal circuit is formed whose throughput rate is greater than the feed rate. The volume that is fed flows off through the light-phase discharge.
- The oil discharge towards the tank is throttled (V3) as far as the motor current allows, or until overflow of the bowl occurs (I_{nom} of drive motor - see name-plate).
- The volume of circulating liquid is set **only** by means of the oil valve V3.

Attention!



To prevent overload of the motor, the rated current (I_{nom}) must not be exceeded.

8.2 Bowl

Self–cleaning bowls need not be taken apart for cleaning at the end of a run, unless the nature of the separated solids makes bowl dismantling for thorough cleaning necessary.

Experience will show how often the bowl has to be dismantled.

The following points are particularly important:

- During the first few months of operation, the lock rings should be removed every two weeks for greasing the threads, to prevent seizing.

Later on, the greasing intervals may be extended.
However the bowl should be dismantled at least every two months for thorough cleaning of the inner bowl parts.



- Never use metal scrapers or metal brushes for cleaning the discs and bowl parts.
- All bowl parts have fine tolerances; it is therefore important that all parts are cleaned thoroughly and are free from burrs.
- Place bowl parts on a rubber mat or wooden grating, never on a stone floor.
- Remove gaskets from the bowl parts and clean grooves and gaskets to prevent corrosion.

Replace damaged gaskets. Swollen gaskets should be left to dry at a warm place so that they can regain their original dimensions and can be re–used.

- Carefully clean the small holes in bowl bottom and the two bowl valves for the supply and discharge of the operating–water to ensure trouble–free performance of the solids ejections.
- Clean and wipe dry guide surfaces and threads of bowl parts and grease them. Spindle cone and inside of bowl hub should be oiled and then wiped clean and dry with a smooth rag.
- The solids collector and solids collector bottom should also be cleaned every time.
- Re–assemble bowl immediately after cleaning. Otherwise the bowl parts must be protected against dust and dirt.

8.3 Frame

When cleaning the frame:

- Never expose the machine to a direct water jet. It must be cleaned by hand, with a sponge or cloth.
  This applies especially to the motor, even if it is enclosed.

8.4 Operating–water feeding system

- The strainer in the water pressure reducer and the small holes in the operating water feeding device should be cleaned every 3 – 6 months.

8.5 Gear chamber

- Whenever changing the oil, clean the gear chamber thoroughly with thin–bodied oil.
- Remove metal particles from walls and corners.
- Do Not use fluffy cleaning rags or cotton waste.

8.6 Prior to a long–term shut–down

- Clean the separator thoroughly (8.2 and 8.3).
- Wipe dry and grease all bowl parts and all unvarnished machine parts.
- Keep the cleaned and greased bowl at a dry place until re–use.
- Store the gaskets in a cool and dry, dustfree room, protected from direct daylight, to prevent them from getting brittle.

Prepare the separator as follows:

- Drain the lube oil.
- Fill gear chamber with a corrosion–protecting oil, e.g. SHELL Ensis 30, up to middle of sight glass.
- Run the separator without bowl for about 2–3 minutes so that all gear parts are covered with corrosion–protecting oil.
  (Strictly adhere to the start–up regulations!)
- The upper spindle end must be
  - oiled by hand
  - protected with neck bearing cover 3.
- Check liquid shut–off valves for tightness, if necessary, disconnect the feed lines.
- Stop operating–water supply by closing the main valve (to prevent water from breaking in after inadvertant opening of the shut–off device).

To obtain permanent protection against corrosion, run the separator every three months without bowl for about 2–3 minutes
(Strictly adhere to the start–up regulations!)

Before re–using the separator:

- Drain the corrosion–protecting oil.
- Fill gear chamber with lube oil (3.1.1) until oil level is slightly above middle of sight glass.
- Run the separator without bowl for about 2–3 minutes **(Strictly adhere to the start–up regulations!)**.

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9.1 Dismantling the vertical gear parts

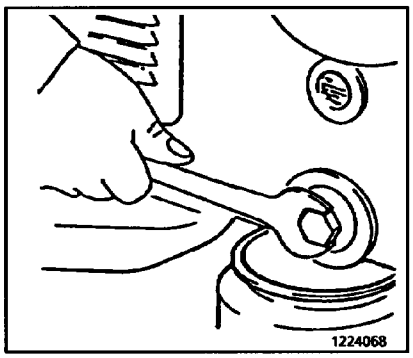


Fig. 135

- Dismantling the bowl.
- Loosen oil drain screw and drain oil into oil pan.

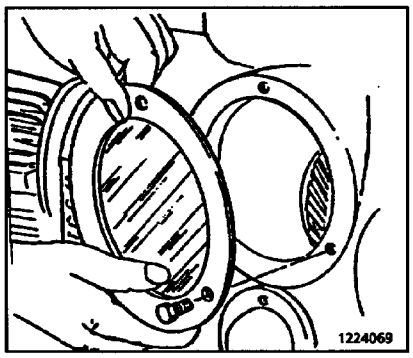


Fig. 136

- Unscrew hex head screws.
- Remove gear sight glass or revolution indicator.

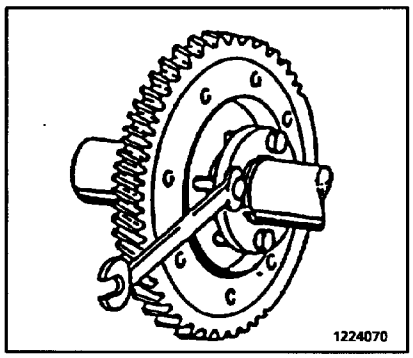


Fig. 137

- Loosen hex head screws in clamp plates of worm wheel.

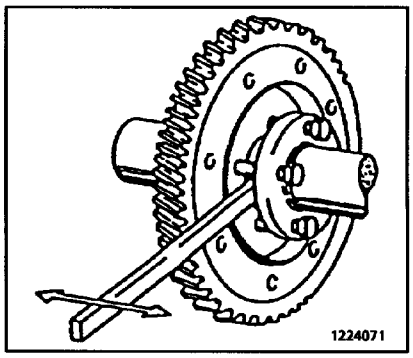


Fig. 138

- Slacken clamp plates until the worm wheel can be moved on worm wheel shaft.
- Push worm wheel to the clutch side.

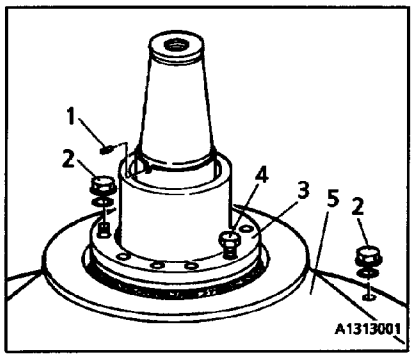


Fig. 139

- Unscrew Allen screws 1 out of sleeve/spindle.
- Unscrew cap nuts 2 of the operating water feeding device.
- Press off ring 3 with hex head screws 4 (M8) which are screwed into the two puller holes.
- Remove protective cover 5.

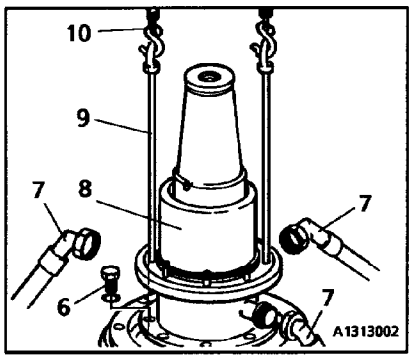


Fig. 140

- Unscrew hex head screws 6.
- Disconnect hoses 7 of the operating water feeding device.
- To pull the operating water 8 feeding device off the spindle:
  - Screw the threaded spindle of the puller device 9 into the taphole and
  - pull off using lifter 10.

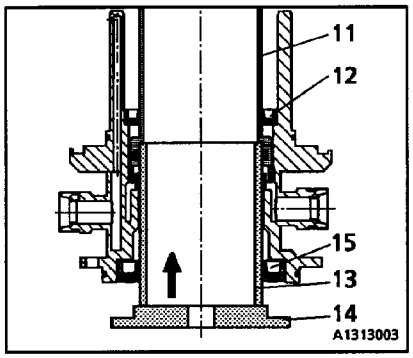


Fig. 141

- Dismantle upper sealing ring 12 and spindle cap 11 with sleeve 13 and centering 14.
- Force out the lower gasket 15 with a screwdriver.

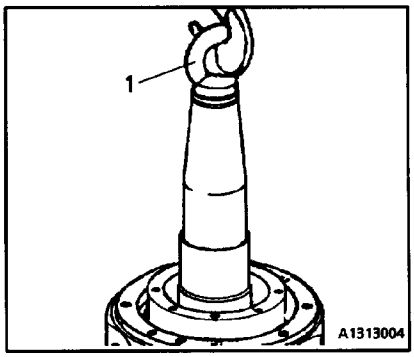


Fig. 142

- Pull out spindle upwards using spindle lifter 1.

9.1.1 Dismantling the neck bearing bridge

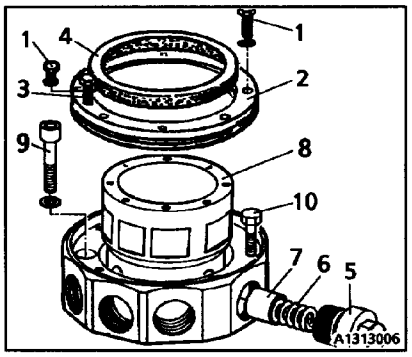


Fig. 143

- Undo screws on ring 2 and force off the ring.
- Dismantle gasket 4.
- Dismantle threaded plugs 5, springs 6 and spring pistons 7.
- Remove neck bearing pressure ring 8.
- Unscrew Allen screws 9.
- Force off neck bearing bridge using hex head screws 10.

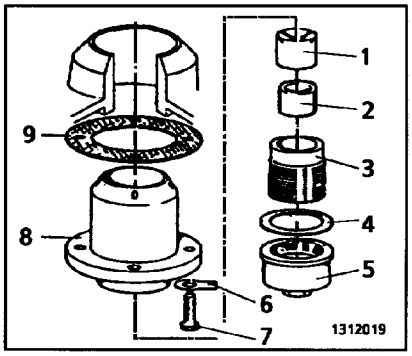


Fig. 144

- Unscrew bottom bearing cap 5 and remove gasket 4.
- Unscrew bottom bearing threaded piece 3 and remove it together with spring column 2 and bottom bearing pressure piece 1.

- In case the bottom bearing housing 8 must be replaced:
  - straighten tab washers 6,
  - unscrew hex head screws 7.
  - Screw two screws 7 into the tapholes of bottom bearing housing
  - force out bottom bearing housing by pressing it downwards.

9.1.2 Removal of ball bearing and worm

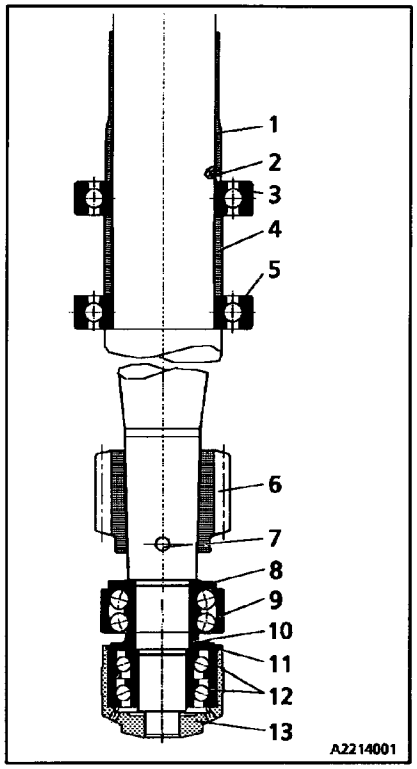


Fig. 145

- Pull out the following components using a commercially available puller:
  - Ball bearing protection ring 10, angular contact ball bearings 12 and bottom bearing housing 13,
  - Ball bearing protection ring 8 and pendulum ball bearings 9.
- Knock out cylindrical notched pin 7.
- Remove worm 6.
- Unscrew screw 2 and remove sleeve 1.
- Grooved ball bearings 3 and 5 and sleeve 4.
- Press snap ring 11 out of the groove of bottom bearing housing.
- Remove angular contact ball bearing 12 from bottom bearing housing 13.

9.2 Installing the vertical gear parts

Proceed in reverse order of removal (9.1). **and according to the following instructions:**

- When the worm on the spindle is worn, the worm wheel will have to be replaced at the same time.

Prior to installing the vertical gear parts

- thorougly clean the gear chamber (8.5).



- Check condition of the ball bearings on the spindle. Be sure only to use ball bearings fulfilling the WS quality standard – see parts list.
- **For safety reasons, replace ball bearings on worm spindle every 5 000 operating hours.**
- Before fitting the ball bearings, heat them up in oil to approx. 80 °C.
- Replace the two angular contact ball bearings always at the same time.

Important!

The angular contact ball bearings may be axially charged in one direction only. They have to be inserted so that the **large shoulder of the inner ring of each bearing** shows upwards (towards the bowl).



If the bearings are not correctly positioned, they will be prematurely destroyed!

Each time when having installed the vertical gear parts,



- install the bowl and check its height
- for possible re–adjustment (9.3).

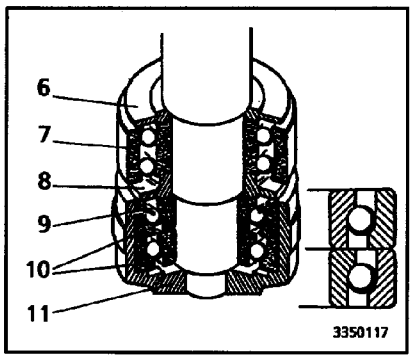


Fig. 146

Install the bearings:

- the angular contact ball bearings must be
  - warmed up,
  - then pushed onto the spindle.
- Slip snap ring 9 over the ball bearings.
- Let the ball bearings cool down.
- Slide bottom bearing housing 11 over the ball bearings.

- Press snap ring 9 into the groove of the bottom bearing pressure housing.
- Install worm spindle without neck bearing bridge.

Important!



Insert worm spindle without hitting on top of the spindle. If necessary, deburr the bottom bearing housing with a fine emery cloth.

9.2.1 Assembling the neck bearing bridge

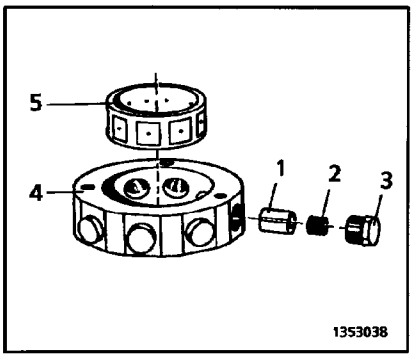


Fig. 147

- Insert pressure ring 5 in neck bearing bridge 4 (recesses of pressure ring must be in line with bores of neck bearing bridge).
- Put neck bearing springs 2 into spring pistons 1.
- Grease spring pistons thoroughly.

- Thread in plugs 3 with
  - spring pistons 1 and
  - neck bearing springs 2 so that pressure ring 5 lies centrically in neck bearing bridge 4.
- Then tighten the plugs evenly and crosswise.

Before fitting the neck bearing bridge, check the gaskets for proper condition.

9.2.2 Fitting the spring column into the bottom bearing

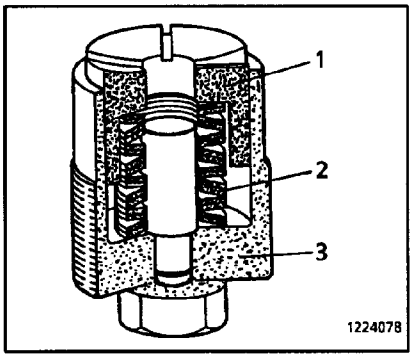


Fig. 148

- Slide cup springs 2 onto bolt of bottom bearing threaded piece 3 as illustrated in the adjacent figure:
  - two springs in a set,
  - eight sets altogether.
- Insert bottom bearing pressure piece 1 into bottom bearing threaded piece 3, sliding it over the cup springs.

9.2.3 Fitting the operating water feeding device

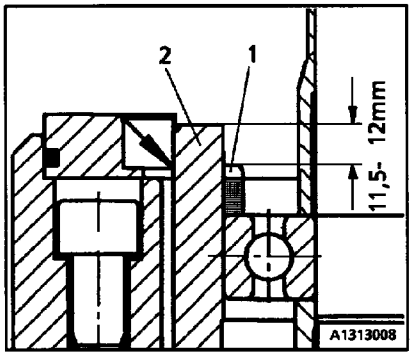


Fig. 149

- Before fitting the operating water feeding device, the distance between the cams of distance ring 1 and the pressure ring 2 must be checked.

  Distance cam distance ring to pressure ring

  < 11.5 mm – file off cam.

  > 12 mm – Weld on cam or order new distance ring from the factory stating the dimension of the required cam height.

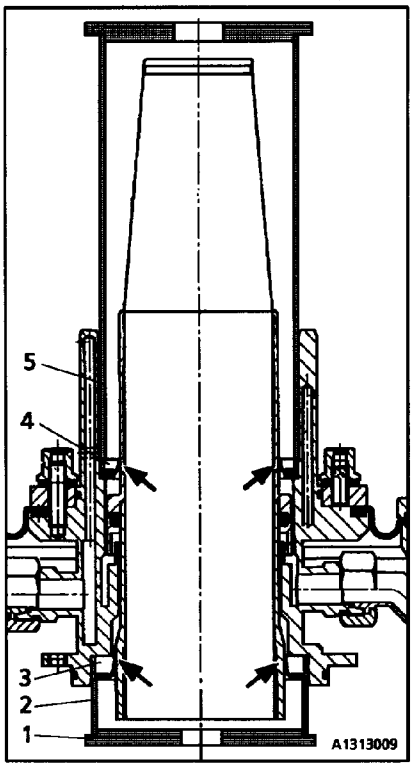


Fig. 150

Fitting the sealing rings:

- Fit the lower sealing ring 3 with sleeve 2 and centering disc 3.
- Assemble operating water feeding device.
- Fit upper sealing ring 4 with sleeve 5 and centering disk 1.

  Make sure the sealing rings are positioned correctly! (see arrows)

- Then proceed in reverse order of removal.

9.3 Bowl Height

The bowl height is adjusted at the factory before the separator is shipped.

9.3.1 Inspection

The bowl height must be checked for re–adjustment

- before the first start of the separator,
- after re–assembling the vertical gear parts,
- after exchanging the bowl,
- after exchanging the centripetal pump,
- as soon as the centripetal pump shows any grinding marks.

Prerequiste to correct bowl height adjustment is that

- the bowl is properly closed,
  (the "O" marks on bowl lock ring and on bowl bottom must be in line with each other.)
- the hood is properly seated on the solids collector,
- the fastening screws of the hood are tight,
- the upper centripetal pump is screwed onto the lower centripetal pump as far as it will go,
- the centripetal pumps are screwed into the disk as far as it will go.

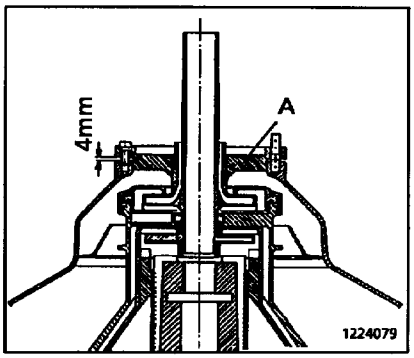


Fig. 151

The bowl height is correct when the disk A with screwed–in centripetal pumps can be raised by about 4 mm. Otherwise the bowl height has to be re–adjusted.

Distance between disk and hood

< 5 mm, bowl is too low.
> 6 mm, bowl is too high.

9.3.2 Adjusting

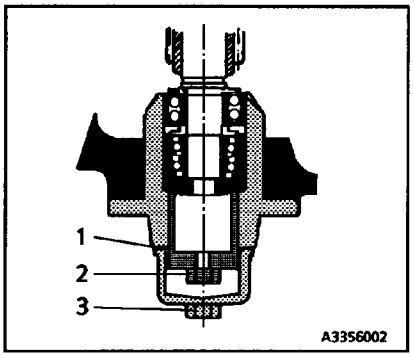


Fig. 152

- Unscrew the bottom bearing cap 3.
- Take off gasket **1**.
- Adjust the bowl height by turning bottom bearing threaded piece 2.
  (1 revolution ≃ 2 mm)

  Bowl is too low »» *turn bottom bearing threaded piece clockwise.*

  Bowl is too high »» *turn bottom bearing threaded piece anti-clockwise .*

- Finally screw on bottom bearing cap 3 with fitted gasket 1. Ensure that the bottom bearing threaded piece does not rotate.

After adjusting the bowl height, the distance between the cams of the distance ring and the pressure ring (9.2.3)!

9.4 Removal of the horizontal gear parts

Work on electric lines may only be carried out by a qualified electrician under observation of the safety regualtions.

For removal of the horizontal gear parts proceed according to the following sections:

9.4.1 Motor

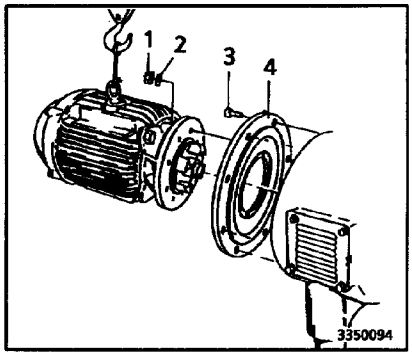


Fig. 153

- Disconnect motor.
- Suspend motor from a suitable hoist, tighten rope.
- Unscrew hexagon nuts 1.
- Remove lock washers 2.
- Remove motor together with cam hub.
- Unscrew Allen screws 3.
- Remove intermediate flange 4.

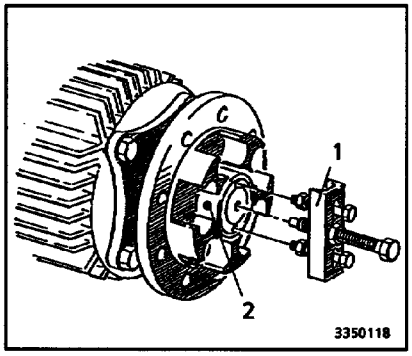


Fig. 154

Removing the cam hub:

- Remove threaded pin 2.
- Pull hub off the motor shaft end using device 1.

9.4.2 Fluid clutch

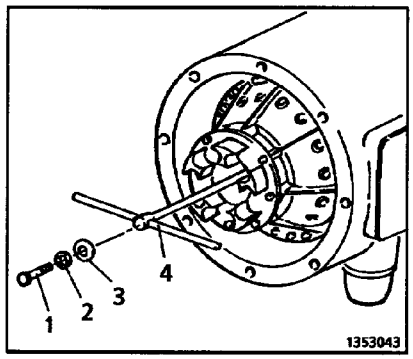


Fig. 155

- Unscrew hex head screw 1. Note tension of cup spring 3 !
- Remove washer 2 and cup spring 3.
- To remove fluid clutch from cone of worm wheel shaft use device 4.

9.4.3 Worm wheel shaft

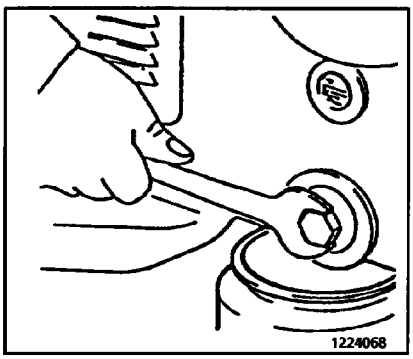


Fig. 156

- Loosen oil drain screw.
- Drain oil into oil cup.

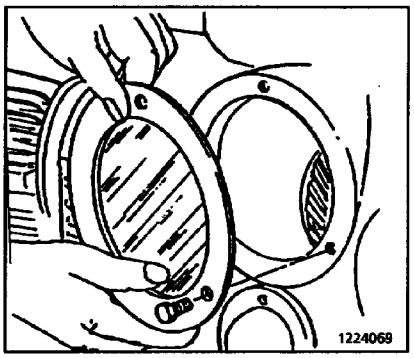


Fig. 157

- Unscrew hex head screws.
- Remove gear sight glass or revolution indicator.

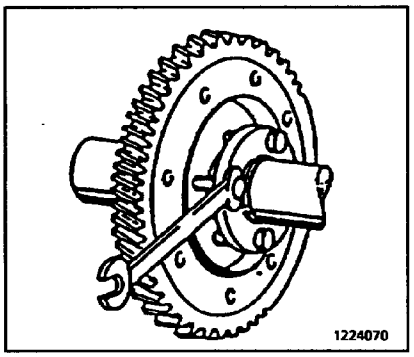


Fig. 158

- Loosen hex head screws in clamp plates of worm wheel.

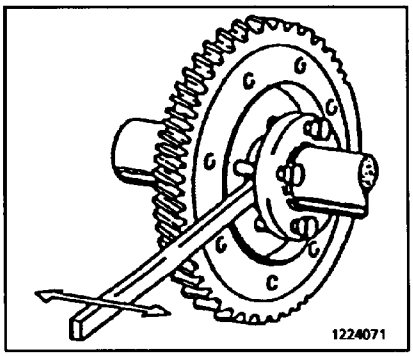


Fig. 159

- Slacken clamp plates until the worm wheel can be moved on worm wheel shaft.
- Push worm wheel to the clutch side.

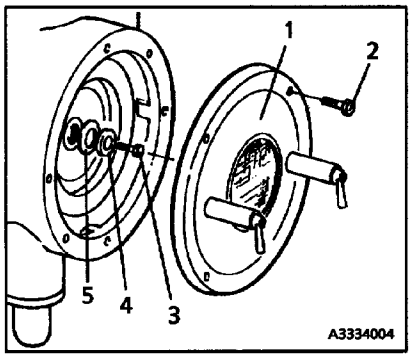


Fig. 160

- Unscrew allen screws 2.
- Remove fan cover 1.
- Unscrew hex head screw 3 from worm wheel shaft. Note tension of cup spring!
- Remove centering disc 4 and cup spring 5.

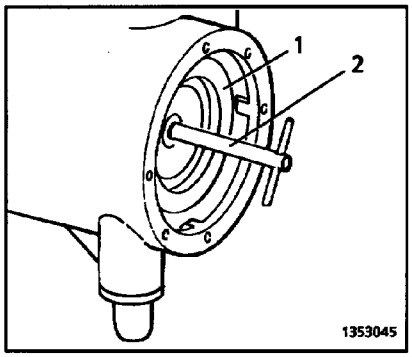


Fig. 161

- Remove brake pulley 1 from cone of worm wheel shaft using device 2 (fluid clutch/brake pulley).

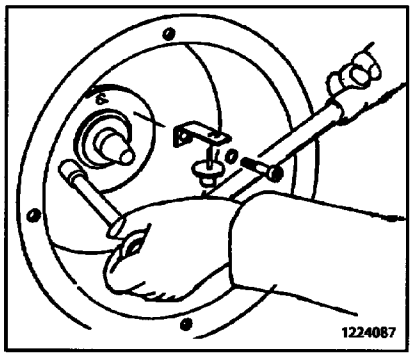


Fig. 162

- Unscrew Allen screws from bearing cover (brake side)
- Remove holder and proximity switch.

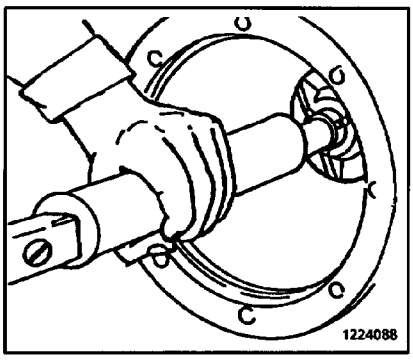


Fig. 163

- Place a hard wooden block against worm wheel shaft.
- Drive out worm wheel shaft together with ball bearing, nut and bearing cover towards *brake side* .
  (Shaft must have completely loosened from the ball bearing on the motor side).
- Pull out the worm wheel shaft by hand; while doing so, hold worm wheel to prevent damage to gear teeth.
- Take worm wheel with clamp plates out of the gear housing.

9.4.4 Removing the grooved ball bearing (motor side)

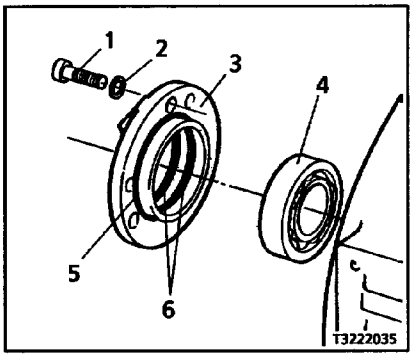


Fig. 164

- Unscrew hex head screws 1 and remove lock washers 2.
- Remove bearing cover 3 together with sealing rings 6 and gasket 5.
- Drive out the ball bearing from the gear chamber side by placing a brass mandrel on the inner ring of the ball bearing.

9.4.5 Removing the angular contact ball bearing (brake side)

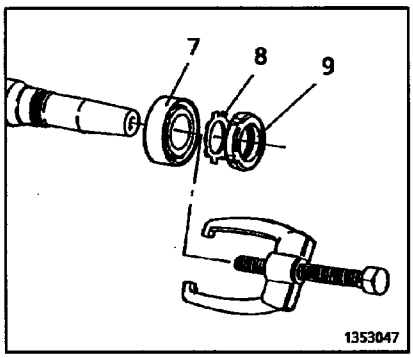


Fig. 165

- Lift tab of washer 8 out of groove of nut 9.
- Loosen and unscrew grooved nut using the pivoted hook wrench.
- Remove tab washer 8.
- Withdraw angular contact ball bearing 7 from worm wheel shaft using a commercial pulling device.

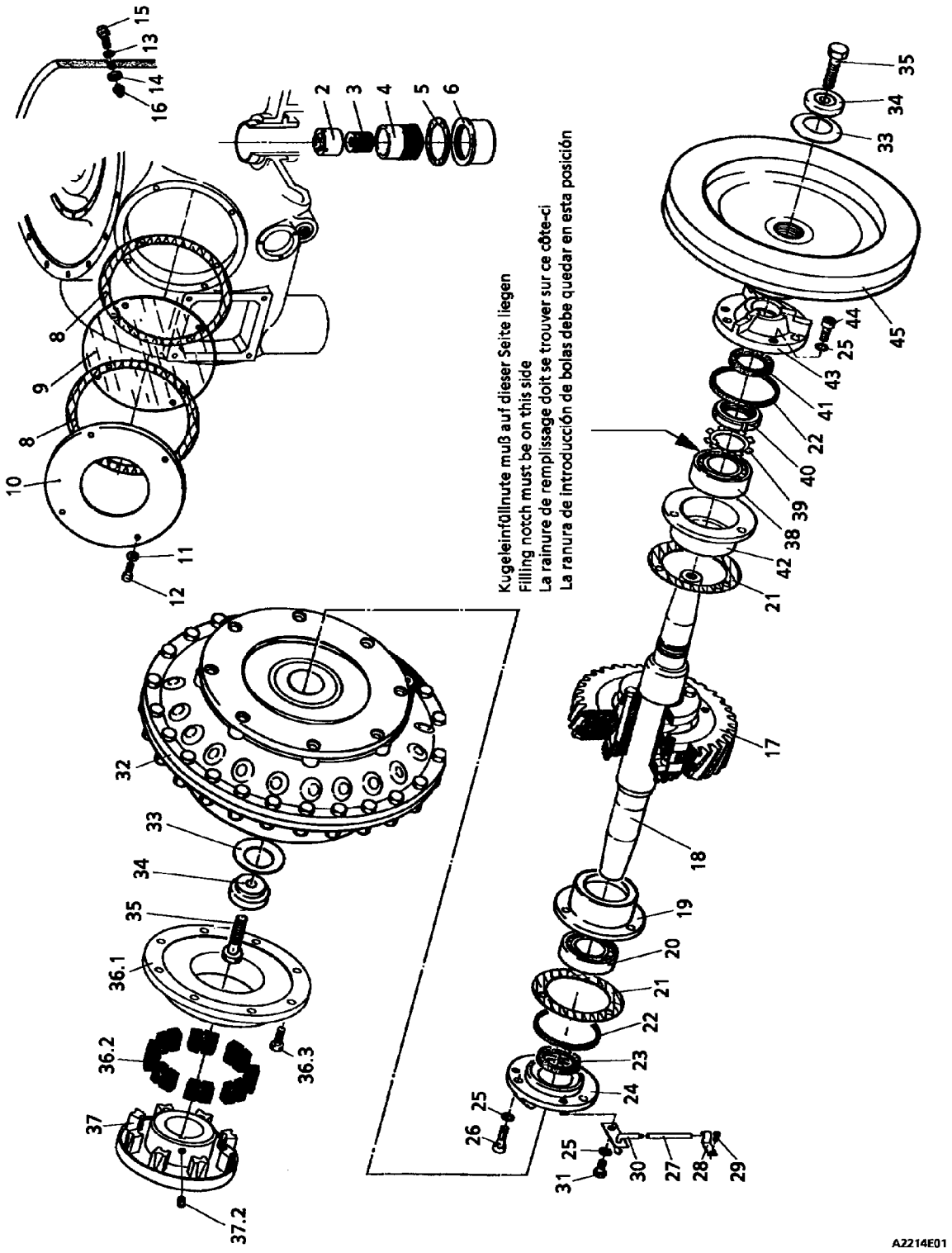

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Filling notch must be on this side
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La ranura de introducción de bolas debe quedar en esta posición
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Fig.166

9.5 Re–assembly of the horizontal gear parts

Note:

For safety reasons replace ball bearings of worm wheel shaft every 10 000 operating hours.



- Fit angular contact ball bearing 38 onto worm wheel shaft 8.
  Note: Filling notch of bearing must face the brake side.
- Fit tab washer 39.
- Tighten grooved nut 40.
- Bend one tab of washer into a groove of the nut so that self–loosening of the nut is impossible.
- Install grooved ball bearing 20 into bearing housing 19.
  Fit bearing cover 24 and fasten with hex head screws 31.
- Install worm wheel assembly 17 with clamp plates into the gear housing (the flange must face the brake side).

The worm wheel has been balanced in the factory as complete assembly.

Therefore,



- the clamp plates and the toothed rim must not be rotated on the wheel body
- and component parts must not be replaced individually.

When the toothed rim is worn and needs replacement, the entire worm wheel with clamp plates must be replaced. The worm of the spindle must be replaced at the same time.

- Introduce worm wheel shaft 18 into the separator frame from the brake side and slide on the worm wheel.
- Place a hard wooden block against the worm wheel shaft and tap it lightly with a hammer until angular contact ball bearing 38is tightly seated in the housing.
- Install bearing cover 43 with inserted sealing ring 41 and gasket 22.
- Tighten bearing cover 43 with hex head screws 44 (lock washers 25 placed underneath).
  Required Torque: 45 Nm.

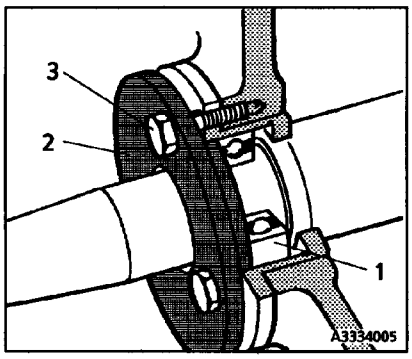


Fig. 167

Installing the grooved ball bearing (motor side) into its final position:

- Remove bearing cover 24.
- Fit grooved ball bearing 1 evenly against collar of worm wheel shaft using
  - device 2 and
  - hex head screws 3.
- Unscrew hex head screws 3.
- Remove device 2.

- Install bearing cover 24 with inserted sealing ring 23 and gasket 22.
- Tighten bearing cover 24 with hex head screws 31 (including washers 25).

- Push worm wheel towards brake side until it rests against shoulder of worm wheel shaft.
- Tighten the screws in both clamp plates evenly and crosswise.
  Required torque: 45 Nm.
- The end of the worm wheel shaft must be
  - greased thinly,
  - cleaned and wiped dry with a rag.
- Place brake pulley 45 onto cone of worm wheel shaft.
- Fasten brake pulley using head head screw 35, washer 34 and cup spring 33.

  Required torque: 150 Nm.
- Place fluid clutch 32 onto cone of worm wheel shaft.
- Fasten fluid clutch 32 by means of hex head screw 35, washer 34 and cup spring 33.
- **Required torque: 150 Nm**

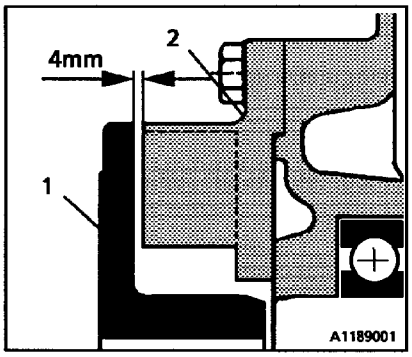


Fig. 168

When fitting the motor, note:

The distance between cam hub 1 and fluid clutch 2 must be **4 mm** .

Check the distance after fitting

- another motor,
- another cam hub,
- fluid clutch,
- another worm wheel shaft.

If readjustment becomes necessary:

- Displace cam hub on the motor shaft.
- Re–drill motor shaft for threaded pin.

Fill:

- gear chamber in accordance with chapter 3.1.1.

Check:

- direction of rotation of bowl (4.2).
- spindle speed with a hand tachometer (4.3).

Running–in:

- When using new gear parts (worm wheel, worm*let the clarifier run for approx. one hour **without bowl.**
  While running in the gear parts, switch the motor on and off several times.

10 Lubrication

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10.2 Checking the oil level 108
10.3 Re–filling of oil 109
10.4 Type of oil 110
10.5 Dismantling 111
10.6 Re–assembly 113

10.1 General

The fluid clutch (Turbo Clutch)

- transmits the power from motor to gear,
- gradually brings the bowl to it rated speed,
- eliminates premature wear on gear parts and on motor.

The motor power is transmitted by means of a closed oil circuit between a primary wheel driven by the motor shaft and a secondary wheel driving the worm wheel shaft of the clarifier.

The fluid clutch must be filled with the correct amount of oil (10.2), to ensure that the bowl reaches its rated speed within its starting time (4.4).

If the clutch contains	
not enough oil:	too much oil:
• Starting time of bowl too long. • Slippage too great.	• Starting time of bowl too short. • Overload of motor and gear.

- The oil in the clutch has to be changed
  - every 10 000 working hours
  - on the occasion of an inspection and when replacing the ball bearings of the worm spindle and worm wheel shaft.

The clutch requires:

approx. 7,2 litres of oil when using a n = 155 rpm motor

apprrox. 6,1 litres of oil when using a n = 145 rpm motor



For checking the oil level, proceed according to the instructions in sect 10.2.

Be sure to use only the type of oil specified in sect. 10.4.

10.2 Checking the oil level

- The oil level has to be checked
  - before the initial start–up of the clarifier,
  - every time after re–filling of oil,
  - once a month since in the course of time small oil losses may occur.
  - **Note: Check oil level only after oil has cooled down!**

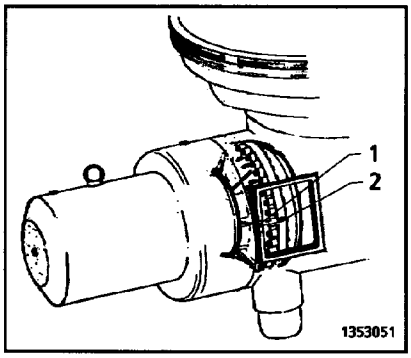


Fig. 169

Brand new clarifier:

Mark on oil level plate 1 must be in line with lower edge of taphole 2. Oil level must then be up to the lower edge of taphole 2 .
If a replacement clutch is installed, the existing oil level indicator plate is no longer valid and must be re–adjusted according to the instructions given in chapter "clarifier with replacement clutch".

For checking the oil level, proceed as follows:

The clarifier still has its original clutch:

- Remove the ventilation grid so that the oil level indicator plate can be seen.
- Turn the fluid clutch until threaded plug 2 can be unscrewed without oil flowing out.
- Unscrew threaded plug with a wrench.
- Then turn clutch until the lower edge of receiving hole for threaded plug and the mark of the oil level plate are in line with each other (see 10.2).

In this position, the oil is just about to overflow.

If this is not the case, refill oil as described under 10.3.

The clarifier has a replacement clutch:

- If the clutch is replaced, then the original oil level indicator plate is no longer valid!
- The clutch has been filled with the correct amount of oil if the peak power consumption when the machine is starting up reaches a level which is twice as high as the rated power consumption.
- If an exact measurement of power consumption is not possible, then the correct amount of oil can be determined by measuring the speed of the horizontal drive shaft in the clarifier.
  When the clarifier is operating at its rated throughput, the shaft should be rotating at approx.

  1 420 rpm – (50 Hz) or at
  1 710 rpm – (60 Hz).
- If the peak power consumption or the speed of the shaft is much higher than these figures, then there is too much oil in the clutch.
- If they are much lower than these figures, then there is not enough oil.
- Once the correct amount of oil has been established, the oil level indicator plate must be re–set accordingly.

10.3 Re–filling of oil

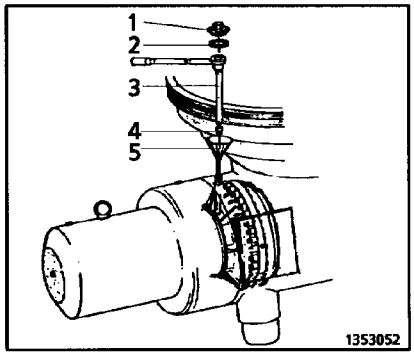


Fig. 170

- Unscrew lock screw 1.
- Unscrew oil fill screw 4 with wrench 3.
  Pour in oil using funnel 5.
- Check oil level (11.2)
- Screw in lock screw including gasket 2 **tighly.**

10.4 Type of oil

For filling the fluid clutch use only

steam turbine oil TDL 32 (WS part–no. 0015–0050–090)

This oil complies with the following specification deviating to some extent from DIN:

Designation	Lubricating oil TDL 32 – DIN 51515 (steam turbine oil with additives giving increased protection against corrosion and increased resistance to aging.
Kinematic viscosity	32 ± 3,2 mm^2/s (cSt) at 40 °C
Density / 15 °C	max. 0,900 g/ml
Pour point	≤ 9°C
Open flash point	≥ 210°C to Cleveland
Corrosive effect on - copper - steel	 degree of corrosion 2 – 100 A3 according to DIN 51759 degree of corrosion 0 – A according to DIN 51585
Aging characteristics	Increase of the neutralization number after 1000 h max. 2,0 mg KOH/g oil according to DIN 51587

The following branded oil meets this requirement: **Shell Turbo Oil T 32.**



Steam turbine oils TDL 32 of other brands may be used provided they comply with the above specification.

Each clarifier is supplied with an amount of TDL 32 oil which is sufficient for one filling.

10.5 Dismantling

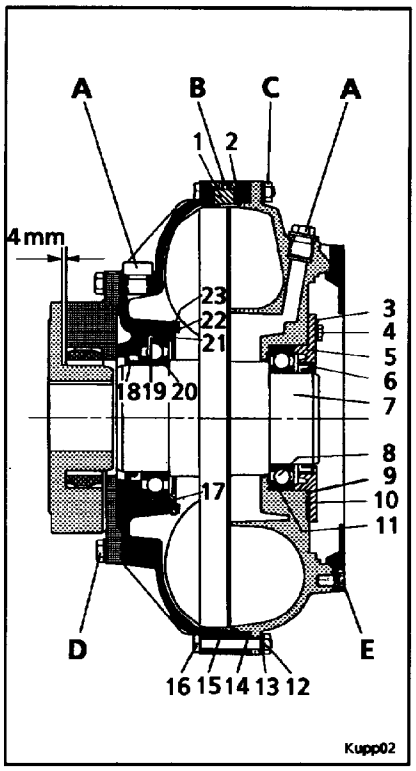


Fig. 171

The fluid clutch should not be dismantled on site.
If damage occurs, the clutch should be returned to the manufacturer for repair to assure correct fitting of the spare parts and, hence, proper functioning of the clutch.
On request, a spare clutch can be placed at your disposal.

If, however, you decide to remove leakage of the clutch on site, we recommend to check first the sealing ring 6 and to replace it, if necessary.

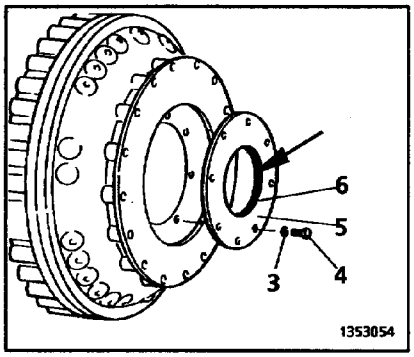


Fig. 172

Removal of sealing ring 6

- Unscrew screws 4 with lock washers 3 and remove sealing ring cover 5.
- Force out sealing ring 6 using a screwdriver.
- Now check the sealing ring and replace it when its sealing lip is no more soft and pliable.

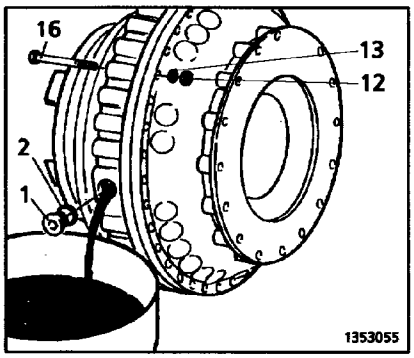


Fig. 173

Removal of sealing ring 18 and ball bearing

- Unscrew threaded plug 1 together with gasket 2.
- Drain the oil.
- Unscrew hexagon nuts 12.
- Take out screws 16 and lock washers 13.

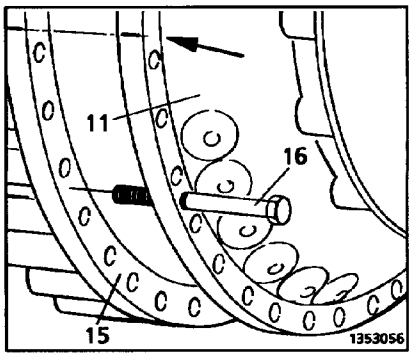


Fig. 174

- Screw two screws 16 into the tapholes of the primary wheel 11.
- Force primary wheel off the clutch casing 15.
  Secondary wheel remains in primary wheel.
  Before dismantling be sure to mark:
  - clutch casing 15 and
  - primary wheel **11.**
    (After re–assembly marks must be aligned – otherwise unbalance).

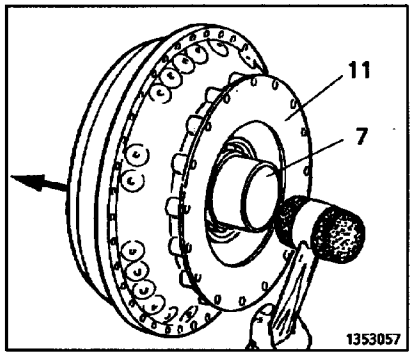


Fig. 175

- Separate primary wheel 11 from secondary wheel 7 by rapping with a rubber hammer against hub of secondary wheel.
  Ball bearing 8 remains in primary wheel 11.

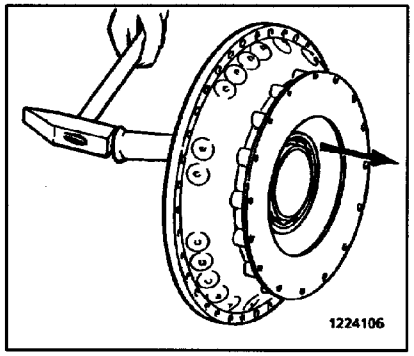


Fig. 176

- Use mandrel and hammer to drive ball bearing 8 out of primary wheel 11.

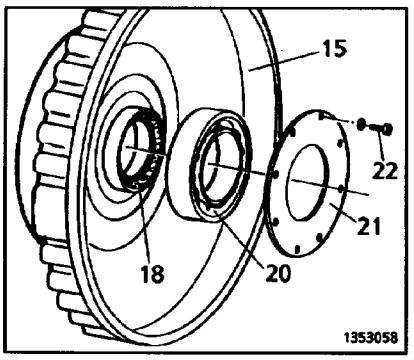


Fig. 177

- Unscrew Allen screws 22 from clutch casing 15.
- Remove oil retaining ring 21.
- Drive ball bearing 20 and sealing ring 18 out of the clutch casing using a mandrel and hammer.

10.6 Re–assembly

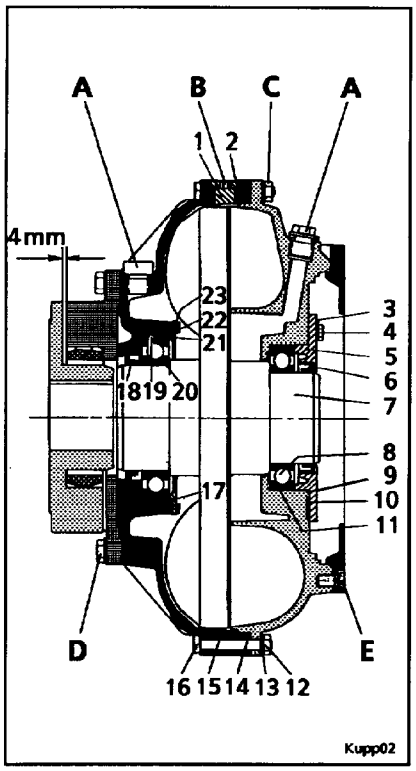


Fig. 178

For re–assembly of the fluid clutch proceed in reverse order of dismantling. The following should be kept in mind.

Torque:
A = 150 Nm
B = 95 Nm
C = 46 Nm
D = 80 Nm
E = 40 Nm.

Glue screws Pos. E using Loctite 245.

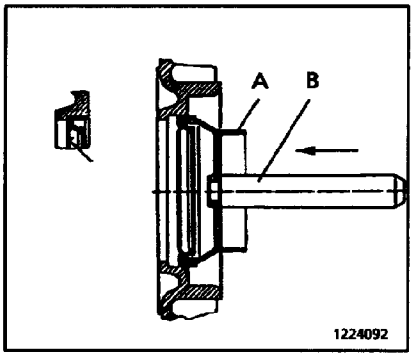


Fig. 179

- Moisten sealing rings.
- Screw bolt B into disk A and attach it to sealing ring 18.
- Press sealing ring 18 into the clutch casing by lightly tapping on bolt B.
- Screw bolt B into the other side of disk A and press sealing ring 6 into sealing ring cover 5 proceeding in the same way as above.

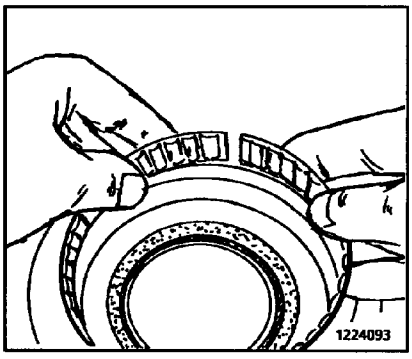


Fig. 180

- Insert spacer ring 19 into clutch casing 15.
- Insert spacer ring 10 into primary wheel 11.

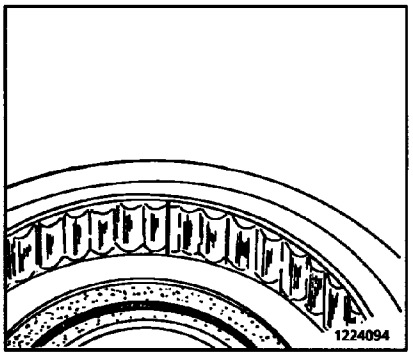


Fig. 181

Note:

The bevelled edge of each ring must snap into the groove of the bearing neck. This will ensure that the spacer rings cannot move axially.

- Press ball bearing 20 into the clutch casing and ball bearing 8 into the primary wheel.
  Check if the ball bearings pressed into the spacer rings have an absolutely tight fit. If this is not the case, the spacer rings have to be replaced.
- Apply some oil–resistant sealing compound (Atmosit or Kermon)to oil retaining ring 21.
- Then fasten oil retaining ring 21 to clutch casing with Allen screws 22. Be sure to fit lock washer 23.
- Insert gasket 9 into groove of primary wheel.
- Fasten cover 5 to primary wheel with hex head screws 4. Be sure to fit lock washers.



- Press secondary hub with secondary wheel 7 into clutch casing.
  The surfaces contacting the sealing rings must be perfectly smooth to ensure oil–tightness of the fluid clutch.
  If necessary, re–polish contact surfaces.

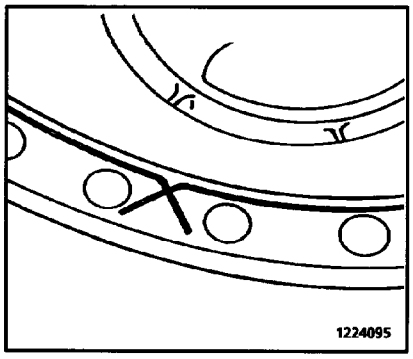


Fig. 182

- Grease Teflon packing cord 14 and place it on the sealing surface of the clutch casing.
  (next to the inner rim of the casing)
- Make sure cord ends are crossed.

Sealing surfaces of primary wheel and clutch casing must be in perfect condition.
Do not coat sealing surfaces with sealing compound.

- Press primary wheel on secondary hub so that the marks on primary wheel and clutch casing are in line with each other.



- Screw primary wheel and clutch casing together.

After re–installation the clutch must be re–balanced!

- Fill clutch with oil.

11 Trouble Shooting

11.1 Fault detection – Mechanical function 116
11.2 Separational function 120

11.1 Fault detection – Mechanical function

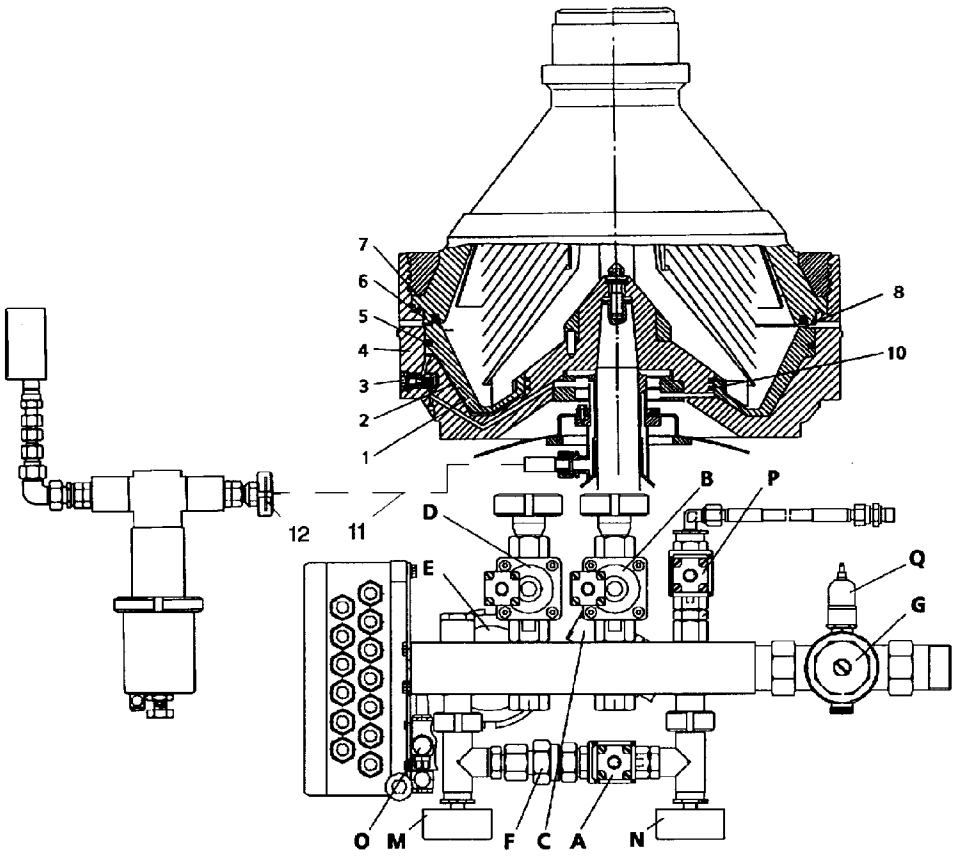
Fault	Possible causes	Remedies
The bowl does not come up to rated speed or takes too long to do so (see 4.4).	Brakes are on.	Release brakes by turning handles clockwise.
	Motor is incorrectly connected.	See wiring diagram.
	The fluid clutch does not contain enough oil or clutch is leaky.	Refill oil (see 10.3). Re–tighten nuts of screws on clutch. If sealing rings and do not seal properly, ask for a reconditioned clutch in exchange for your clutch.
	Bowl is too high or too low and, therefore, rubs against centripetal pump.	Adjust to proper bowl height (see 9.3).
	Clamp plates are not tight enough; worm wheel slips on shaft.	Tighten long hex head screws on worm wheel evenly and *firmly.* Tighten crosswise, by single turns, with a torque of 45 Nm.
	Product feed valve is open.	Close product feed valve.
The bowl speed drops during operation.	The fluid clutch does not contain enough oil.	Refill oil (see 10.3).
	Motor speed drops during operation.	Inspect motor and line voltage.
	Main bowl gasket in bowl top is damaged.	Replace the gasket (see sect. 5.6).
	Gaskets in bowl valves are damaged; the bowl loses sealing water.	Replace gaskets (see 5.7).
	Gaskets in bowl valves are damaged. The bowl looses closing water.	Replace gaskets (5.7). Temporarily, the bowl can be kept closed by operating the manual lever of the solenoid valve for closing water.

Fault	Possible causes	Remedies
The bowl comes up to rated speed too quickly (in less than 8 minutes). Motor pulls too high a starting current.	The clutch contains too much oil.	Check oil level (see 10.2). Drain excess oil.
Uneven run of the separator.	Incomplete solids ejection. The remaining solids have deposited unevenly in the bowl.	Perform several partial ejections (7.5.2). If this does not improve conditions, close the bowl and fill it with water to attenuate the increased vibrations occurring during slowing–down of the bowl.Stop the separator. Apply brakes. If bowl is leaking, leave feed open. Clean bowl thoroughly. Remove protruding edges of bowl gasket with a knife (see sketch).
	Bowl is not properly assembled or, if plant has several separators, parts of different bowls may have been interchanged.	Assemble bowl properly (see 5.4).
	Tension of disc stack has slackened.	Make sure bowl lock ring is screwed on tightly (see 5.4). Check disc count. If necessary, add spare disc or compensating disc.
	The bowl is damaged and, therefore, out of balance.	Send the bowl to the factory for repair. Do not make your own repairs. **Do not weld or solder as this would weaken the bowl material – danger to life!**
	Neck bearing springs are weak or broken.	Replace all neck bearing springs.

Fault	Possible causes	Remedies
Uneven run of the separator (cont'd.).	Ball bearings are worn.	Replace damaged bearings. **IMPORTANT:** When replacing, use only the high precision ball bearings as specified in the Parts List.
Oil losses from the fluid clutch during the acceleration phase.	Insufficient cooling of the clutch during start–up	Check cooling of the clutch. Insert new fusible plug in clutch.
Bowl lock ring is difficult to loosen.	Bowl has not been dismantled at regular intervals (see 8.2).	Unscrewing of the bowl lock ring can be very much facilitated by blocking the bowl, which is accomplished by putting wedges between bowl bottom and solids collector.
	Gear parts are in bad condition as a result of	Clean gear chamber thoroughly (see 8.5).
	1. normal wear,	Replace damaged gear parts (see 9.1 and 9.4).
	2. premature wear caused by:	
	a) lack of oil *	Change oil (see chapt. 3.1.3).
	b) oil of too low a viscosity, *	If necessary, change oil more often.
	c) metal abrasives present in the lubricating oil due to the following possible causes: - viscosity of oil is too low, - oil has not been changed in time, - gear chamber has not been cleaned,	
	d) replacement of one gear part only, instead of both parts.	
	*) in general, recognized by blue tempering colour of gear parts.	

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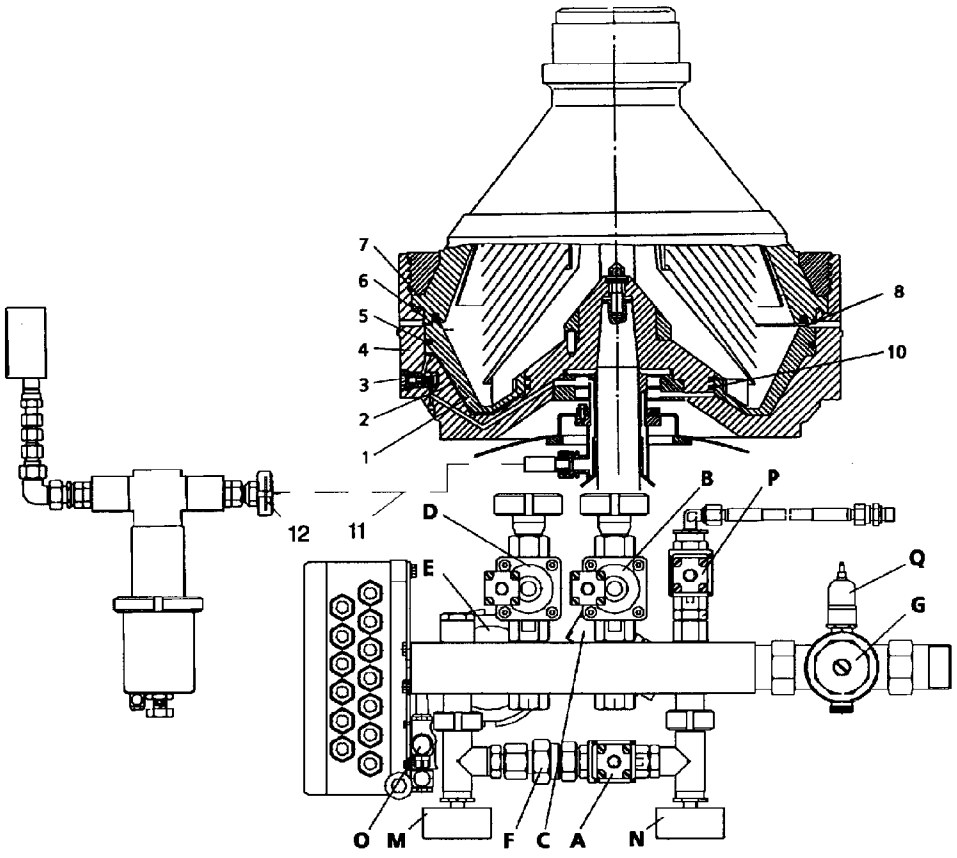
11.2 Separational function



1	Sliding piston	**A**	Solenoid valve for filling water
2	Sealing chamber	**B**	Solenoid valve for closing water
3	Bowl valve	**C**	Solenoid valve for flush water for hood
4	Bowl bottom	**D**	Solenoid valve for opening water
5	Gasket (sliding piston)	**E**	Metering device
6	Gasket (bowl top)	**F**	Check valve
7	Main bowl gasket	**G**	Water pressure reducer
8	Sealing lip (sliding piston)	**M**	Pressure gauge for opening water
10	Gasket (bowl bottom)	**N**	Pressure gauge for closing water
11	Operating–water feeding device	**O**	Pilot valve for metering device
12	Gasket (operating water)	**P**	Clutch cooling water
		Q	Pressure guard for operating water P2214008

Fig. 183

Fault	Possible causes	Remedies
Ejected solids contain too much process liquid.	Too high an amount of ejected solids.	Reduce amount of ejected solids.
	Bowl is leaking.	See below.
The bowl does not close at all. **IMPORTANT:** In this case close product feed or interrupt separation process.	The operating–water supplied is not enough, because:	
	– The water pressure in the supply line to the operating–water connection is too low.	Check line pressure. While the valves are open, the pressure must be at least 2 bar.
	– Water discharge holes in top of operating–water feed 11 are partly clogged due to scale.	Clean water discharges holes.
	– Strainer in water pressure reducer G of operating–water line is clogged.	Clean strainer.
	– Operating–water feed 11 is leaking	Check lines, screw couplings and gaskets.
	– The operating–water feed 11 is clogged.	Clean operating–water feed.
	Gasket 12 has not been inserted or is damaged.	Install or replace gasket.
	Gaskets of piston valves 3 are damaged.	Remove valves (see 5.7). Install new gaskets.
	Gasket 5 in sliding piston is damaged or its edges have been frayed through the up– and down movement of the piston.	Replace damaged gasket. If, however, only the edges of the gasket are frayed and the gasket is not damaged otherwise, it can be re–used after grinding it off with an emery wheel.



1 Sliding piston
2 Sealing chamber
3 Bowl valve
4 Bowl bottom
5 Gasket (sliding piston)
6 Gasket (bowl top)
7 Main bowl gasket
8 Sealing lip (sliding piston)
10 Gasket (bowl bottom)
11 Operating–water feeding device
12 Gasket (operating water)

A Solenoid valve for filling water
B Solenoid valve for closing water
C Solenoid valve for flush water for hood
D Solenoid valve for opening water
E Metering device
F Check valve
G Water pressure reducer
M Pressure gauge for opening water
N Pressure gauge for closing water
O Pilot valve for metering device
P Clutch cooling water
Q Pressure guard for operating water P2214008

Fig. 184

Fault	Possible causes	Remedies
The bowl does not close and open properly.	Gasket 5 in sliding piston does not fit properly at all points of the guide surfaces, thus failing to seal properly.	If necessary, stretch gasket. Before installing the gasket **lightly** grease groove in sliding piston.
	Gasket 7 in bowl top is damaged.	Replace gasket (see 5.6).
	Gaskets 10 in bowl bottom have not been inserted or are damaged.	Insert gaskets or replace them.
	Gasket 5 in sliding piston is uneven in height.	Replace gasket. The difference in height on a gasket must not exceed 0.25 mm.
	Sealing surface 8 of sliding piston is damaged.	Replace the sliding piston.
The bowl does not open at all or not completely.	Dirt or rubber particles have settled between sliding piston 1 and bowl bottom 4.	Clean bowl parts. Round off edges of gaskets. Replace damaged gaskets. Grease guide surfaces with the special lubricating paste supplied.
	Closing chamber 2 between bowl bottom and sliding piston is soiled.	Remove sliding piston 1 and clean closing chamber.
	The drill holes in bowl valves 3 are clogged.	Remove the valves (see 5.7) and clean them.
	The bowl receives no or too little opening water for the following reasons (check gauge M does not indicate):	
	– Non–return valve F is dirty or defective.	Clean or replace non–return valve.
	– Solenoid valve A or D is defective.	Replace solenoid valve.
	– Air pressure for metering unit E is too low.	Increase air pressure to > 4 bar.
	– Opening periods of solenoid valves are not adjusted correctly.	Check program times on control unit (see function diagram).

Fault	Possible causes	Remedies
The bowl opens during separation.	Solenoid valve B is defective.	Check solenoid valve.
	No closing–water pulses.	Check operating unit and closing–water valve.

12 Lubrication and maintenance

12.1 Lubrication chart 126
12.2 Maintenance schedule 127

12.1 Lubrication chart

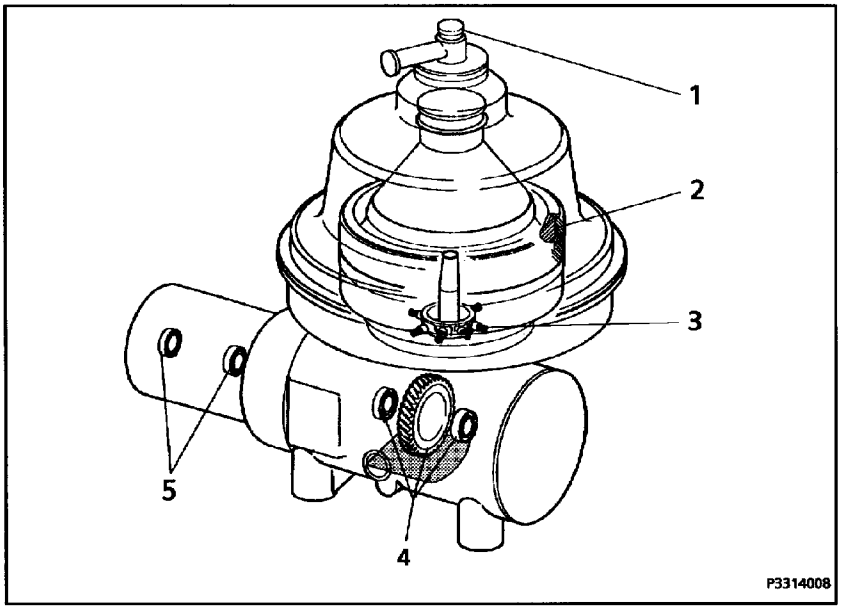


Fig. 185

No. in Fig.	Lubricant		Lubrication interval		Lubrication qty.	Lubrication point
	DIN	ISO	per year	after hours		
1	Klüber grease KSB 8			as required	10 cm^3	Threads and fittings
2	Klüber grease KSB 8			before each assembly	150 cm^3	Threads and sliding surfaces of bowl
3	Roller bearing grease K3K		2x	1 500	20 cm^3	Neck bearing springs, spring pistons.
4	Roller bearing grease K3K		2x	1 500	10 cm^3	Manually-operated parts (valves, tools, etc.).
5	Lube oil CLP 220 DIN 51502	CC 220	2x	see 3.1.1	see 3.1.2	Gear chamber
6	Steam turbine oil TDL 32 DIN 51502			see 10.1	see 10.4	Fluid clutch
7	according to manufacturer's instructions			acc. manufacturer's instructions	acc. manufacturer's instructions	Motor bearings

12.2 Maintenance schedule

after operating hours						OPERATIONS	every			
250	750	1500	3000	5000	10 000		week	3 months	6 months	1 year
LUBRICATION SCHEDULE										
●						First oil change after initial start–up, and thorough cleaning of gear chamber.				
						Check oil level.	●			
	●					Oil change and thorough cleaning of gear chamber. *			●	
		●				Lubrication of individual operating elements such as brake piston, etc. *			●	
whenever dismantling						Grease threads, contact and guide surfaces of bowl parts (3.2).	whenever dismantling			
acc. to instructions of manufacturer						Re–grease or replace bearings of drive motor.	acc. to instructions of manufacturer			
MAINTENANCE SCHEDULE										
Cleaning										
●						Clean piston valves (5.7).				
	●					Clean strainer in operating–water line.			●	
			●			Clean outlet bores of operating–water feeding device.				
		●				Dismantle and thoroughly clean the bowl. Be sure also to clean the bores and chambers of the hydraulic system.		●		
Check										
		●				Remove and check bowl gaskets. Clean grooves for gaskets and check them for corrosion.		●		
		●				Check starting time and rpm of spindle (bowl speed).			●	
		●				Check thickness of brake liners. Check neck bearing springs and spring pistons.			●	
●						Check oil level in fluid clutch.	4 weeks			
			●			Check toothing of worm wheel gear.				●
		●				Bowl inspection. Check threads of lock rings for corrosion and erosion.				
			●			Check land between solids ejection ports.				
Replacement										
				●		Replace neck bearing springs.				
					●	Fill fluid clutch with fresh oil.				
				●		Replace ball bearings on worm spindle.				
					●	Replace ball bearings of worm wheel shaft.				

* Keep to maintenance intervals even if the operating hours have not been reached.

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13 Parts list

Frame, complete 133
Compensator, compl. 136
Compensator, compl. 137
Brake, compl. 138
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Gear, complete 141
Worm spindle, complete 143
Neck bearing bridge, compl. 145
Fluid clutch, compl. 147
Bowl, complete 149
Ring, compl. 150
Double centripetal pump, cpl. 152
Revolution indicator, complete 153
Sight glass frame compl. 154
Hood, complete 155
Feed and discharge connections, cpl. 157
Operating water connection, cpl. 161
Metering cylinder, complete 162
Water pressure reducer 16/1,5–6 bar 163
Set of tools 165
Set of accessories 168

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Important hints for ordering parts

To ensure correct delivery when ordering parts, please state the following:

• Model of separator	see name-plate e.g. SC 70-06-777
• Serial-No	see name-plate e.g. 1 721 620
• Description	see List of Parts e.g. distributor
• Part-No.	see List of Parts e.g. 3289-1343-000

Only required when ordering bowl parts:

• Bowl Serial-No.	see bowl lock ring and bowl bottom

Part-Numbers ending with letter "L" (e. g. 3289-1021-L) designate parts which are available in different designs for the separator concerned.

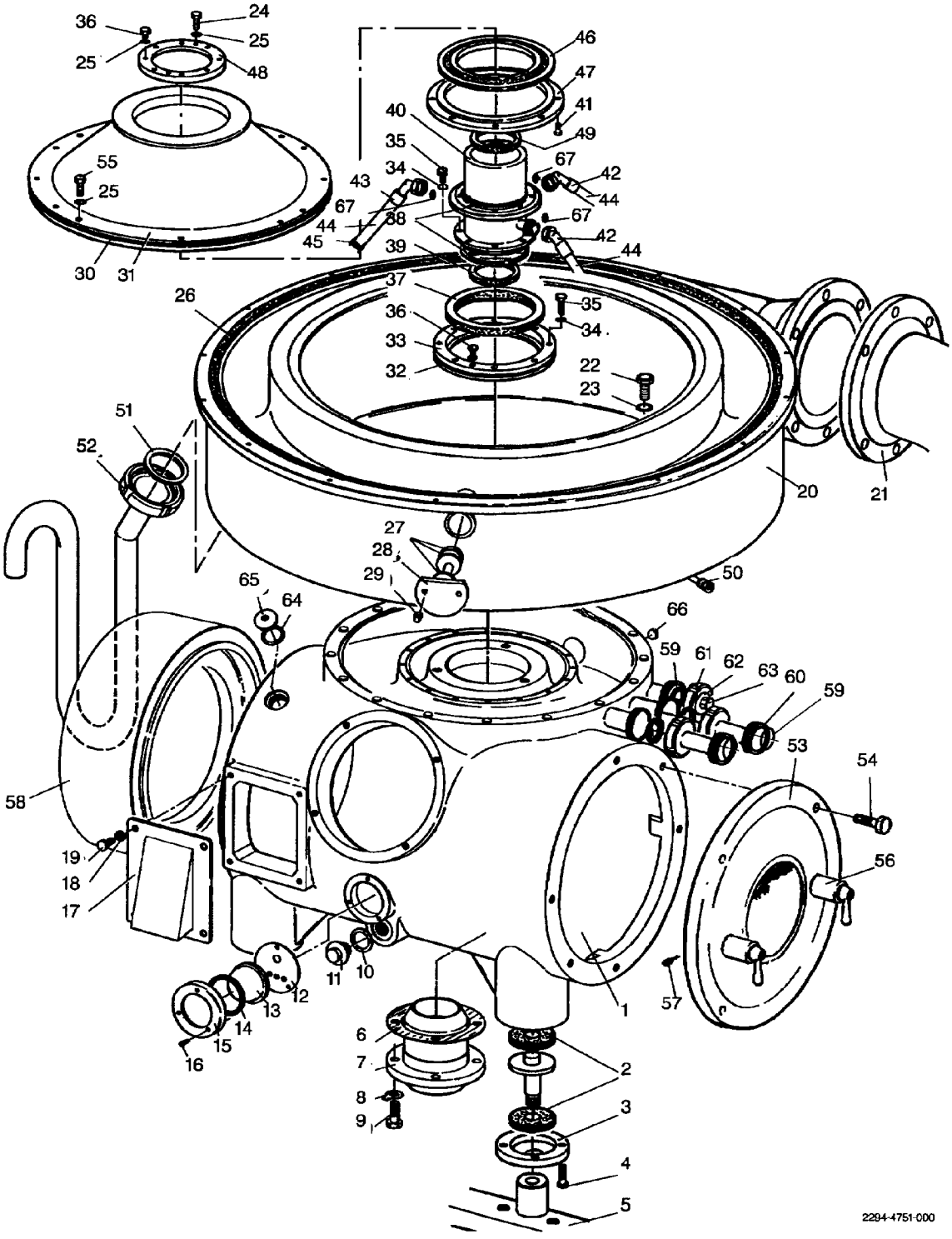

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Fig.186

Pos.	Part-No.	Qty.		Part description	Dimensions
	2294-1100-020			**Frame, complete**	
1	2294-1001-000	1		Lower section of frame	
2	0021-3018-750	8		Rubber-metal cushion	30X92X20
3	3222-1079-000	4		Cover	
4	0019-6513-300	24		Hex head screw ISO 4014	M10X45
5	see page 139	1		Foundation frame compl.	
6	0004-5793-770	1		Gasket	130X204X0.3
7	3050-1112-020	1		Bottom bearing housing .	
8	0026-5894-400	4		Tab washer DIN 93	17
9	0019-7038-400	4		Hex head screw ISO 4017	M16X45
10	0004-5294-780	1		Gasket	27X48X1.5
11	0019-0840-400	1		Screw plug	R3/4IN
12	0004-5406-750	1		Gasket	110X3
13	0001-0027-830	1		Sight glass	80-70
14	0004-5056-780	1		Gasket	70x80x1.5
15	0001-0022-400	1		Sight glass holder	72
16	0019-6845-400	3		Hex head screw ISO 4017	M6X25
17	3350-1085-010	1		Ventilating plate	
18	0026-1371-400	4		Washer DIN 125	13
19	0019-6966-400	4		Hex head screw ISO 4017	M12X20
20	2294-1018-000	1		Solids collector	
21	see page 136	1		Compensator	
22	0019-7037-400	15		Hex head screw ISO 4017	M16X40
23	0004-2509-400	15		Gasket	UA22X16X1.5
24	0019-6903-400	12		Hex head screw ISO 4017	M8X20
25	0004-2873-400	24		Gasket	UA12X8.2X1
26	0004-2389-608	1		Packing cord	10X16x3700
27	0007-1907-750	3		Gasket	49X3,5
28	1313-1183-010	1		Plug	
29	0013-0404-400	2		Cap nut DIN 1587	M 8
30	0007-3032-750	1		Gasket	568X6
31	1313-1262-000	1		Protective hood	
32	0007-2574-750	1		Gasket	218.5x4.5
33	1313-1157-020	1		Ring	
34	0004-2873-400	19		Gasket	UA12X8.2X1
35	0019-6907-400	4		Hex head screw ISO 4017	M8X30
36	0019-6897-400	8		Hex head screw ISO 4017	M8X8
37	0004-2677-750	1		Sealing ring DIN 3760	AS160X190X15
38	0007-2648-750	2		Gasket	120X3
39	0004-2719-850	1		Sealing ring	HN2380-1-84.7X110X12
40	1247-1219-000	1		Operating-water feeding system	
41	0019-6901-400	15		Hex head screw ISO 4017	M8X16
42	0018-6295-400	3		Connection piece	A25-DN16
43	0018-6294-400	3		Connection piece	A35-DN16
44	0018-6293-758	2		High-pressure hose	2TE-16
45	0018-5318-300	6		Hose clip DIN 3017	AL20-32

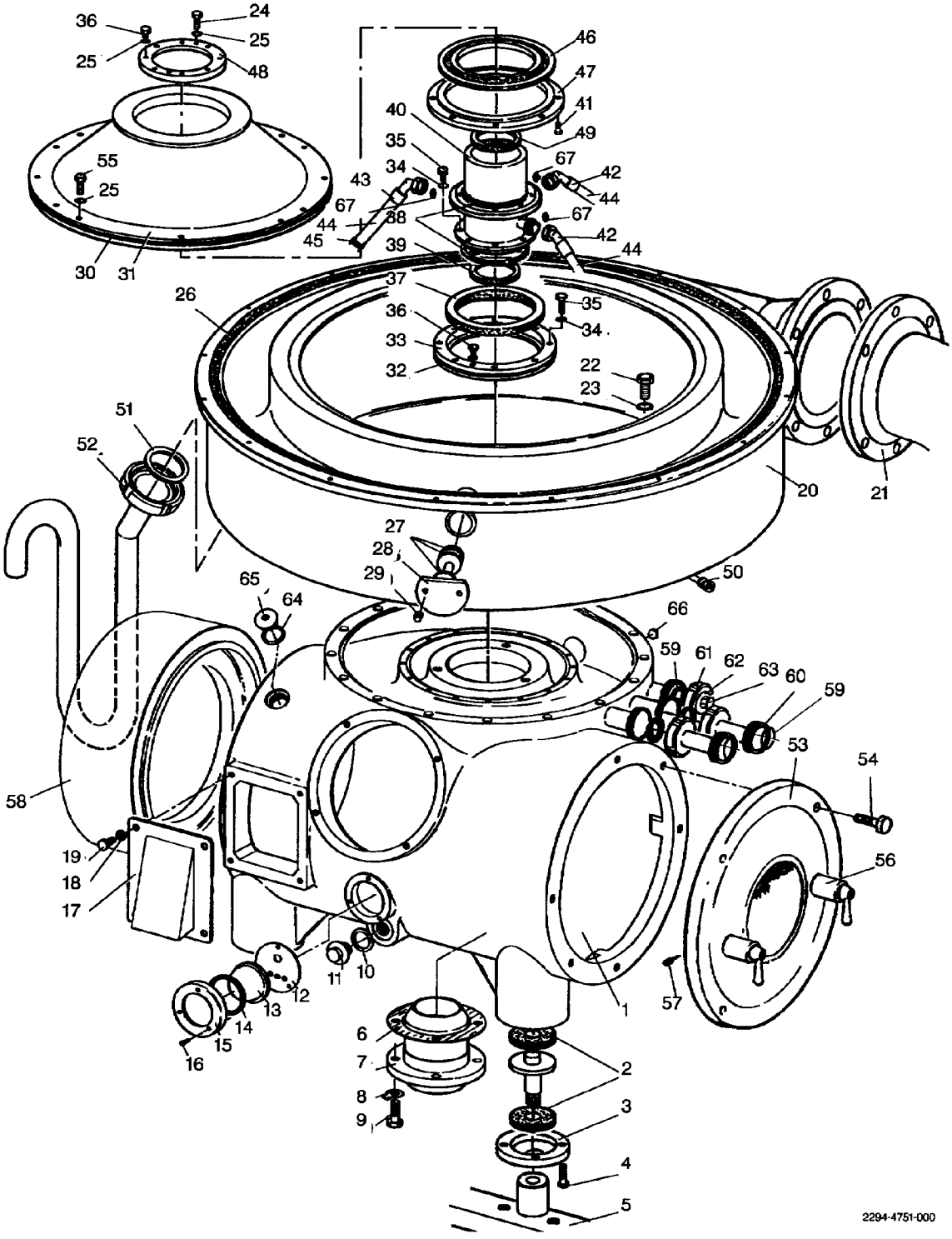

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Fig.187

Pos.	Part-No.	Qty.		Part description	Dimensions
46	0004-2871-820	1		Diaphragm	156X222X16
47	3370-1157-020	1		Ring	
48	1313-1157-010	1		Ring	
49	0004-2654-850	1		Sealing ring	HN2380-1-80X100X10
50	0007-2003-750	2		Gasket	9x1.5
51	0007-2520-750	1		Gasket DIN 11851	G 80
52	1313-2775-010	1		Siphon	
53	3170-1065-020	1		Fan cover	
54	0019-6200-150	8		Allen screw DIN 912	M16X35
55	0019-6906-400	12		Hex head screw ISO 4017	M8X25
56	see page 138	2		Brake	
57	0019-9063-150	2		Threaded pin DIN 916	AM8X10
58	see page 137	1		Intermediate flange	
59	0007-2208-750	5		Gasket DIN 11851	G 25
60	0018-6278-400	2		Transition piece	25
61	0013-2842-300	1		Grooved coupling nut DIN 11851	F 25
62	0018-4269-400	1		Cone connection	25-R1/2IN
63	0018-1217-600	1		Screw-in connector	12-G1/2IN
64	0007-2229-750	1		Gasket	40X48X5
65	0019-1748-400	1		Screw plug	40X1/14INX10
66	0005-0222-900	1		Screw plug DIN 46320	PG9
67	0007-2413-750	6		Gasket	16X2

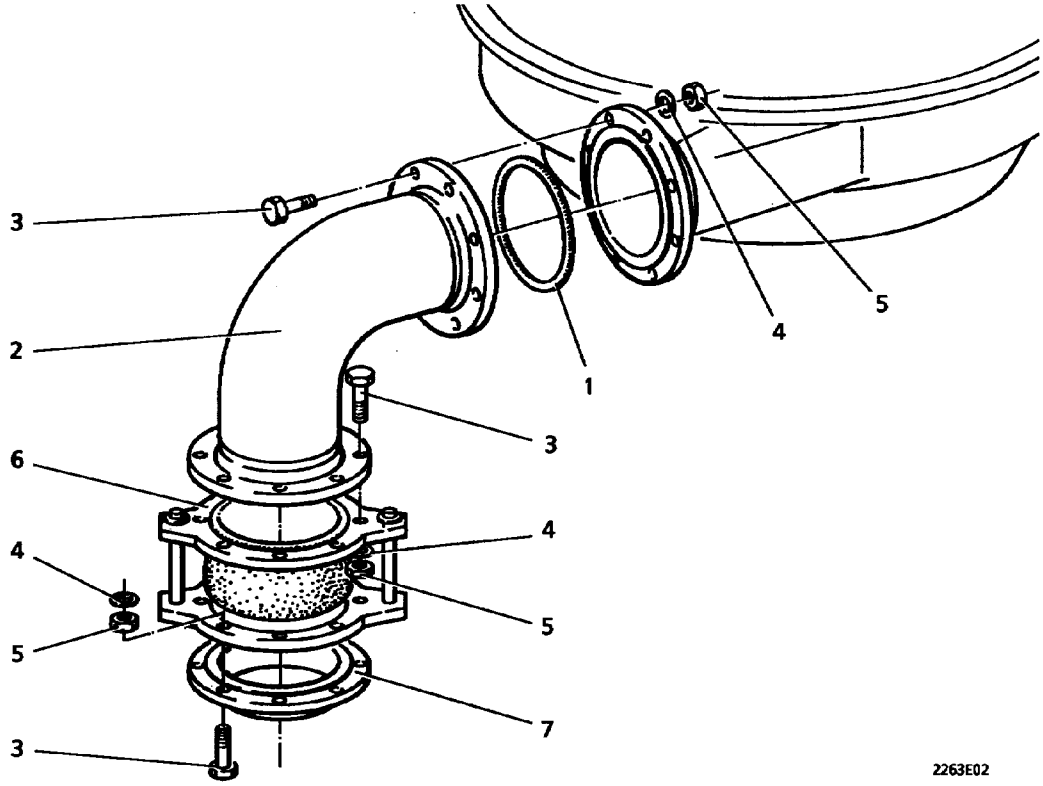


Fig.188

Pos.	Part-No.	Qty.		Part description	Dimensions
–	**3287–2832–L**			**Compensator, compl.**	200PN 6
1	0004–2485–780	1		Gasket DIN 2690	
2	3259–1177–010	1		Pipe bend	
3	0019–6666–400	24		Hex head screw ISO 4014	M20x75
4	0026–1332–300	24		Lock washer DIN 127	B20
5	0013–0284–400	24		Hexagon nut ISO 4032	M20
6	0018–1209–L	1		Compensator	200–10 bar
7	0001–0764–400	1		Flange DIN 2632	C200x219,1

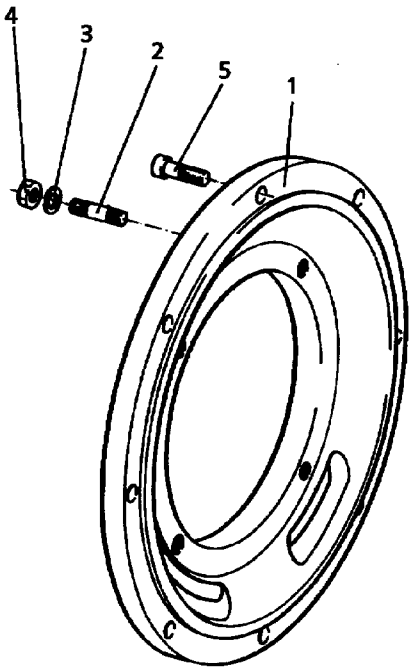


Fig.189

Pos.	Part-No.	Qty.		Part description	Dimensions
–	**3287–2832–000**			**Compensator, compl.**	200PN 6
1	0004–2485–780	1		Gasket DIN 2690	
2	3259–1177–010	1		Pipe bend	
3	0019–6666–400	24		Hex head screw ISO 4014	M20x75
4	0026–1332–300	24		Lock washer DIN 127	B20
5	0013–0284–400	24		Hexagon nut ISO 4032	M20
6	0018–1209–750	1		Compensator	200–10 bar
7	0001–0764–400	1		Flange DIN 2632	C200x219,1

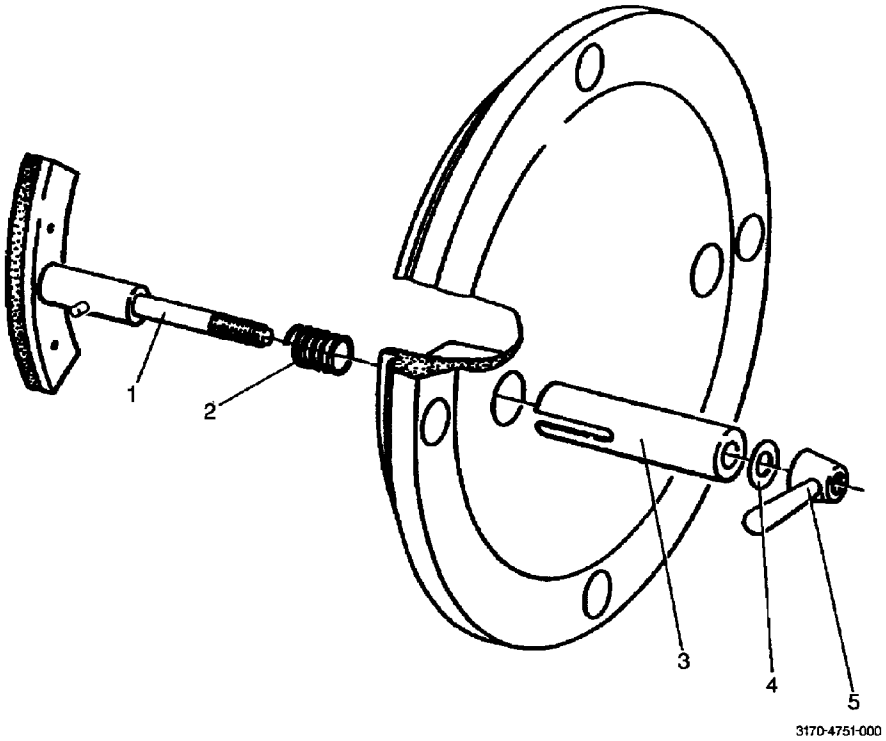


Fig.190

Pos.	Part-No.	Qty.		Part description	Dimensions
–	**3170–1043–000**	**1**		**Brake, compl.**	
1	3170–1031–000	1		Brake bolt	
2	0006–4208–160	1		Cylindrical pressure spring	29x3,5x83
3	0021–3537–300	1		Brake housing	32x42x123
4	0004–1914–720	1		Gasket	17,5x25,5x2
5	0021–3514–300	1		Tapered handle	M16

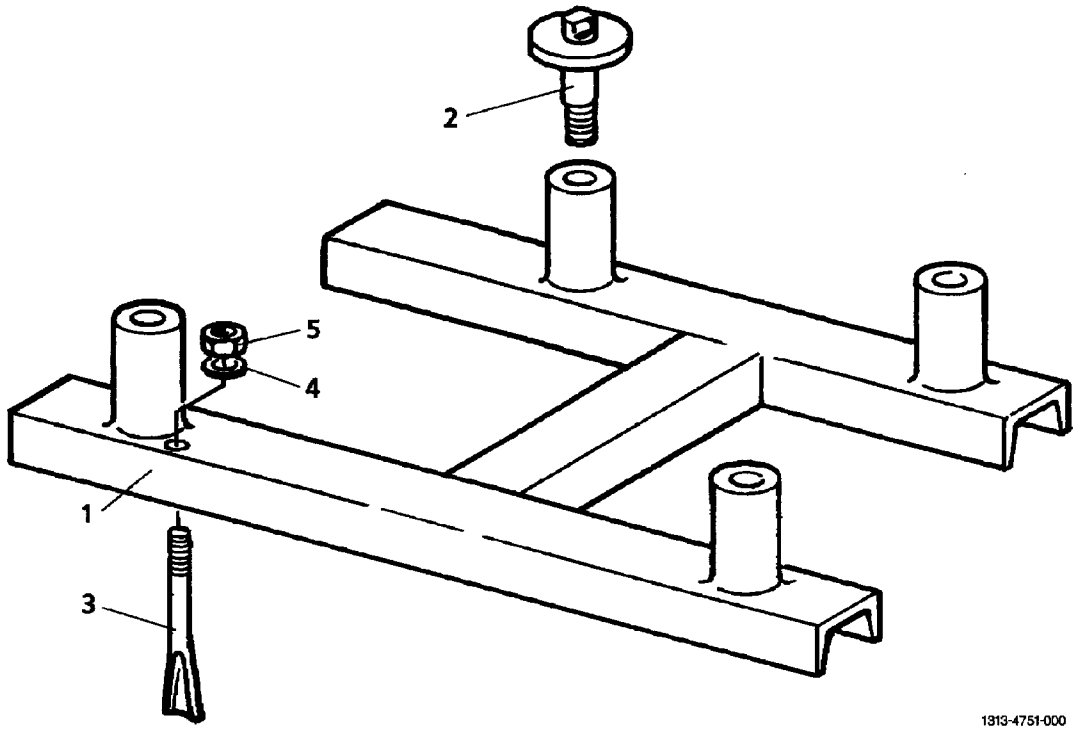


Fig.191

Pos.	Part-No.	Qty.		Part description	Dimensions
–	**1313–1020–010**	**1**		**Foundation frame, compl.**	
1	1313–1003–010	1		Foundation frame	
2	3222–1033–000	4		Bolt	
3	0019–4867–000	8		Anchor bolt DIN 529	FM16x200–MU
4	0026–1335–300	8		Washer DIN 125	17

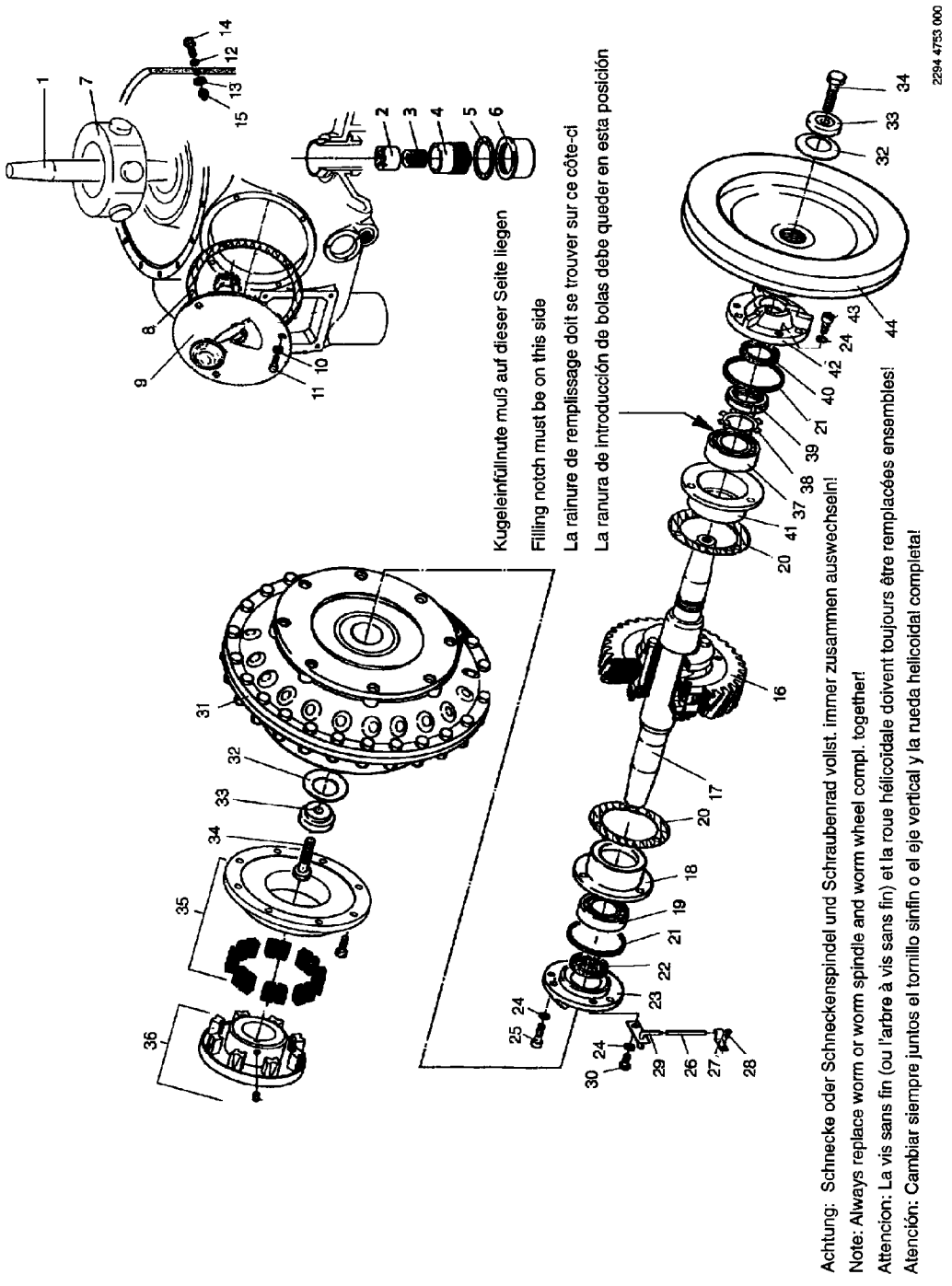

Kugeleinfüllnute muß auf dieser Seite liegen
Filling notch must be on this side
La rainure de remplissage doit se trouver sur ce côté-ci
La ranura de introducción de bolas debe quedar en esta posición
Achtung: Schnecke oder Schneckenspindel und Schraubenrad vollst. immer zusammen auswechseln!
Note: Always replace worm or worm spindle and worm wheel compl. together!
Attencion: La vis sans fin (ou l'arbre à vis sans fin) et la roue hélicoïdale doivent toujours être remplacées ensembles!
Atención: Cambiar siempre juntos el tornillo sinfin o el eje vertical y la rueda helicoidal completa!
2294 4753 000

Fig.192

Pos.	Part-No.	Qty.		Part description	Dimensions
	2294-3300-060			**Gear, complete**	
10	see page 142	1		Worm spindle	
20	0010-8001-200	1		Bottom bearing threaded piece	80
30	0006-4440-160	1		Spring column	A45X48
40	0010-8002-040	1		Bottom bearing threaded piece	80
50	0004-2221-780	1		Gasket	80X108X1.5
60	0010-8003-210	1		Bottom bearing cap	80
70	see page 145	1		Neck bearing bridge	75
80	0004-5762-700	1		Gasket	273X318X2
90	see page 153	1		Revolution indicator	
100	0026-1371-400	4		Washer DIN 125	13
110	0019-6970-400	4		Hex head screw ISO 4017	M12X30
120	0007-2184-750	1		Gasket	15X22X3
130	0013-1023-250	1		Counter nut	EN10242P4-3/8IN
140	1166-3308-000	1		Threaded piece	
150	0018-3725-600	1		Hose connector	R1/4IN-4X6
160	see page 144	1		Worm wheel, complete	
170	2231-3400-020	1		Worm wheel shaft	
180	3351-3136-000	1		Bearing housing	
190	0011-6210-000	1		Grooved ball bearing DIN 625	6210J
200	0004-2559-780	2		Gasket	99X140X1
210	0007-1996-750	2		Gasket	96X4
220	0004-2982-750	1		Sealing ring	A50X68X10
230	2231-3375-040	1		Bearing cover	
240	0026-1337-300	6		Lock washer DIN 127	B10
250	0019-6146-150	3		Allen screw DIN 912	M10X35
260	0018-0585-848	1		Pipe	6X1
270	0018-1276-400	2		Pipe clip	5,5
280	0019-2507-400	2		Pan head screw ISO 1580	M6X10
290	1166-3710-010	1		Nozzle	
300	0019-6929-400	1		Hex head screw ISO 4017	M 10x10
310	see page 146	1		Fluid clutch	422K-TSF
320	0006-4404-010	2		Cup spring	70X40.5X5
330	0026-1834-030	2		Centering disk	14,5X55
340	0019-9371-150	2		Hex head screw DIN 960	M14X1.5X60
350	1166-3259-000	1		Set of clutch connecting parts	
350.1	1166-3283-010	1		- Claw flange	
350.2	1166-3393-000	1		- Set of clutch parts	
350.3	0019-6970-150	8		- Hex head screw ISO 4017	M12X30
360		1	1)	Claw hub, complete	
370	0011-3210-470	1		Angular contact ball bearing DIN 628	3210
380	0026-0915-170	1		Tab washer DIN 5406	MB10
390	0013-0448-090	1		Grooved nut	M50X1.5
400	0004-5566-750	1		Sealing ring	BAFUD3X745X65X8
410	1166-3131-000	1		Bearing housing	
420	2231-3375-020	1		Bearing cover	
430	0019-6513-150	3		Hex head screw ISO 4014	M10X45
440	1229-3368-000	1		Brake pulley	

1) The part number of this part depends on the motor speed as well as on the bowl speed as stated on the name-plate of the machine! Contact agency or factory stating the serial number.

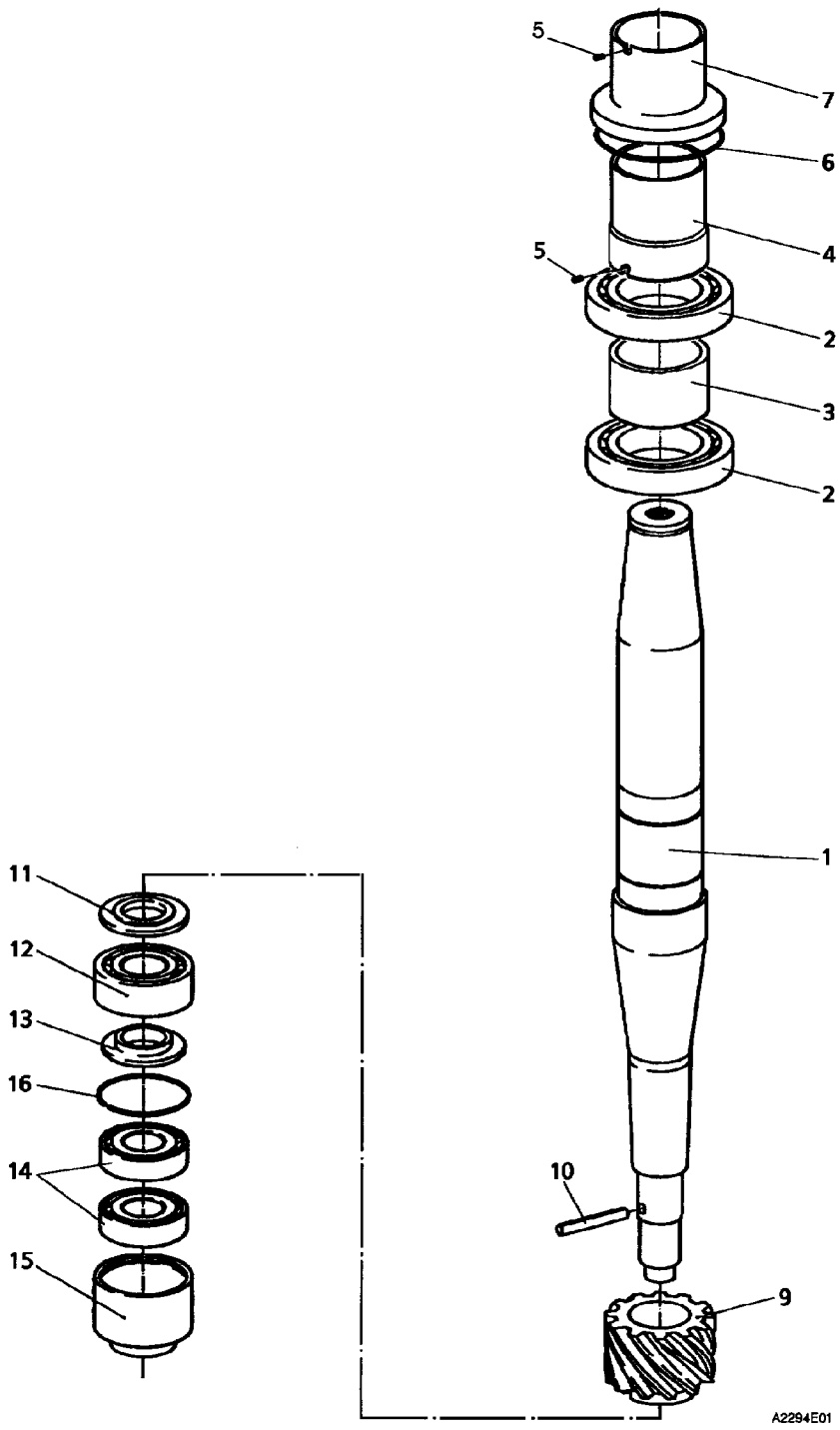


Fig.193

Pos.	Part-No.	Qty.		Part description	Dimensions
	see page 144			**Worm spindle, complete**	
1	1313-3410-000	1		Spindle	
2	0011-6215-110	2		Grooved ball bearing DIN 625	6215-P6
3	0008-7504-010	1		Sleeve	75
4	0008-7504-300	1		Sleeve	75
5	0019-6357-400	2		Threaded pin DIN 915	M6X10
6	0007-3162-750	1		Gasket	78,75X5,33
7	0008-7501-300	1		Spindle cap	75
9	see page 144	1		Worm	
10	0026-1563-120	1		Notched pin ISO 8740	10X70
11	0008-4008-020	1		Ball bearing protection ring	40
12	0011-2308-120	1		Pendulum ball bearing DIN 630	2308-M-P6
13	0008-4008-030	1		Ball bearing protection ring	40
14	0011-7307-100	2		Angular contact ball bearing DIN 628	7307-BECBM-P6
15	0010-8012-020	1		Bottom bearing pressure housing	80
16	0026-2109-170	1		Snap ring	78

Available gear parts

Part–No. 50 Hz Motor speed n = 1 455 min^{-1} Bowl speed n = **4 050** min^{-1}	Part–No. 60 Hz Motor speed n = 1 745 min^{-1} Bowl speed n = **4 035** min^{-1}	Designation
2214-3429-000	2214-3429-010	1) Worm spindle, complete
2225-3423-010	2225-3423-020	1) Worm
2225-3449-010	2225-3449-020	1) Worm wheel with clamp plates, compl.

Part–No. 50 Hz Motor speed n = 1 455 min^{-1} Bowl speed n = **4 750** min^{-1}	Part–No. 60 Hz Motor speed n = 1 745 min^{-1} Bowl speed n = **4 750** min^{-1}	Designation
2294-3429-000	2294-3429-010	1) Worm spindle, complete
2294-3423-000	2294-3423-010	1) Worm
2294-3449-000	2294-3449-010	1) Worm wheel with clamp plates, compl.

1) The part–number of this item depends on the motor speed as well as on the bowl speed as stated on the name–plate of the clarifier. Contact agency or factory stating the serial–number.

Note:
Always replace worm and worm wheel with clamp disk together.

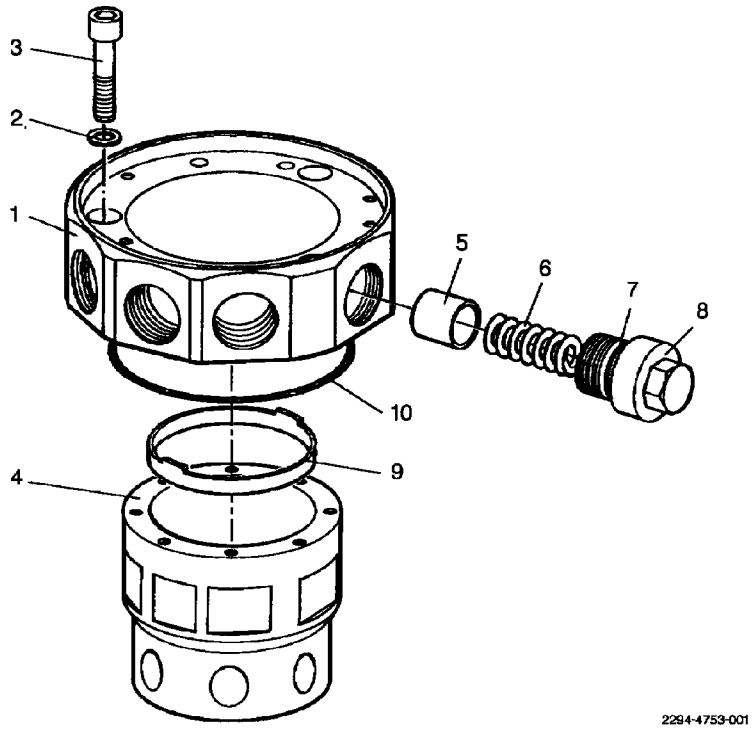


Fig.194

Pos.	Part-No.	Qty.		Part description	Dimensions
	0008–7510–050			**Neck bearing bridge, compl.**	75
1	0008–7506–070	1		Neck bearing bridge	75
2	0004–2509–400	3		Gasket	UA22x16x1,5
3	0019–6206–400	3		Allen screw DIN 912	M16x65
4	0008–7507–070	1		Neck bearing pressure ring	75
5	0026–0841–110	9		Spring piston	35,9x30,8x35
6	0006–4313–090	1		Set of neck bearing springs	30x8x76
7	0007–2580–750	9		Gasket	42x2,5
8	0019–0913–030	9		Threaded plug	M45x1,5–36x40
9	0008–7509–040	1		Spacing ring	75
10	0007–2825–750	1		Gasket	165x4

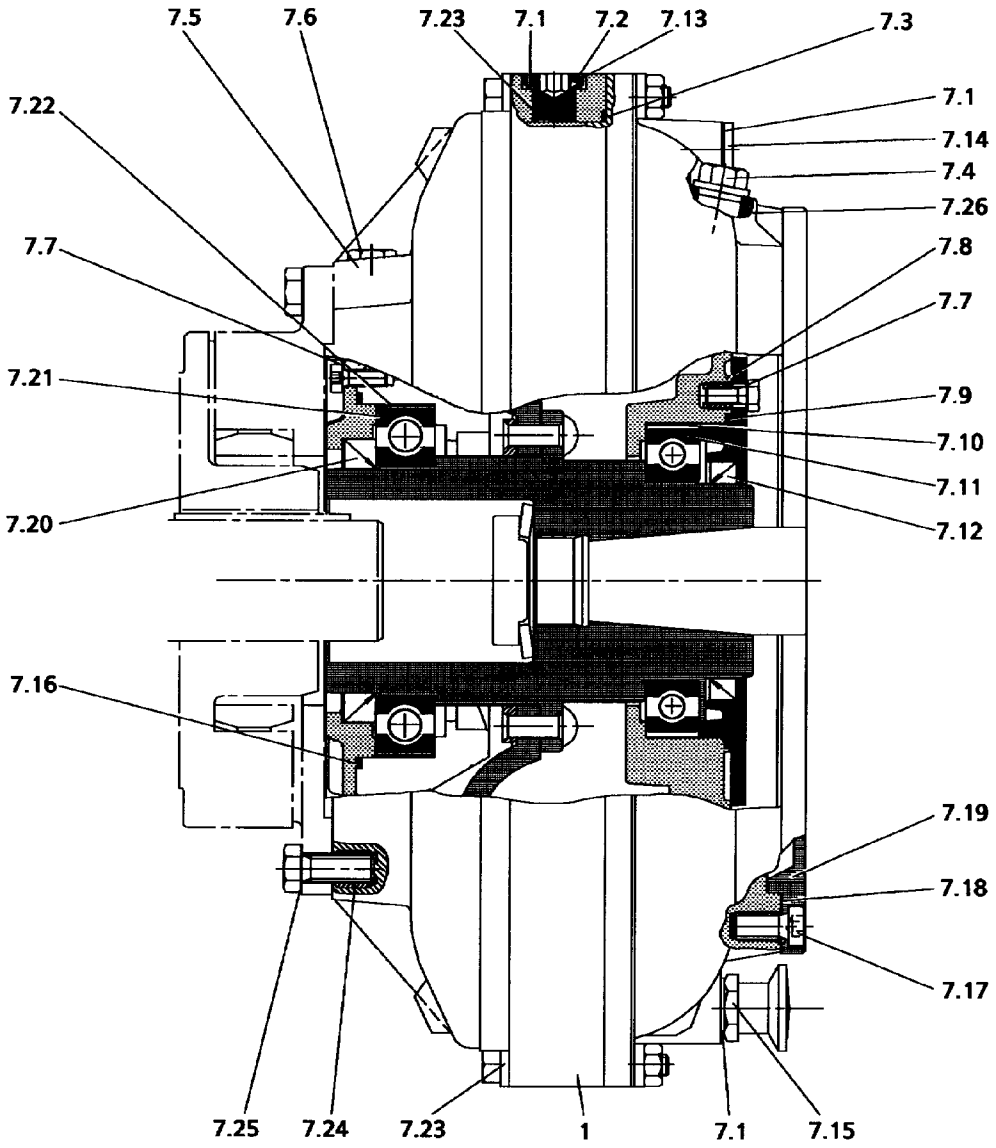

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Fig.195

Pos.	Part-No.	Qty.		Part description	Dimensions
	1166-3280-200			**Fluid clutch, compl.**	422K-TSF
1	1166-3280-170	1		Fluid clutch	
2	0019-1670-000	1		Fusible screw 180 °C	M18x1,5
3	1166-3367-000	1		Ring	
4	0004-2385-858	1		Packing cord	1
5	0019-8440-150	8		Cheese-head screw DIN 7984	M12x25
7	1166-9904-110	1		Set of spare parts for fluid clutch	
7.1	0007-1740-280	4		- Gasket DIN 7603	A 18x24
7.2	0019-1490-000	1		- Threaded plug	M18x1,5x15
7.3	0007-2863-830	1		- Gasket	410x4
7.4	1166-1161-000	1		- Hex head collar screw	M24x1,5x28
7.5	0007-1741-280	1		- Gasket DIN 7603	A 22x29
7.6	0019-1551-090	1		- Screw plug	M22x1,5
7.7	0026-0770-190	16		- Spring washer DIN 137	B 8
7.8	0019-1139-300	8		- Thread insert HELI COIL-	M8x12
7.9	0007-2944-830	1		- Gasket	140x3
7.10	0026-0180-170	1		- Spacer ring	AN 140x24
7.11	0011-6018-400	1		- Grooved ball bearing DIN 625	6018-MC4S0
7.12	0004-2912-830	1		- Shaft sealing ring BAVISSL	90x110x13
7.13	0019-1670-000	1		- Fusible screw 180 °C	M18x1,5
7.14	0019-0861-000	2		- Threaded plug	M18x1,5x15
7.16	0007-2566-830	1		- Gasket	160x3
7.17	0019-8440-150	8		- Cheese-head screw DIN 7984	M12x25
7.18	0004-2385-858	1		- Packing cord	1
7.19	1166-3367-000	1		- Ring	
7.20	0004-2913-830	1		- Shaft sealing ring BAFSVI 1DRW	105x130x13
7.21	0011-6021-400	1		- Grooved ball bearing DIN 625	6021-MC4S1
7.22	0026-0182-170	1		- Spacer ring	AN 160x26
7.23	0019-1137-300	2		- Thread insert HELI COIL	M18x1,5x18
7.24	0019-1141-300	8		- Thread insert HELI COIL	M12x18
7.25	0026-0772-170	8		- Spring washer DIN 137	B12
7.26	0019-1142-300	2		- Thread Insert HELI COIL	M24x1,5x18

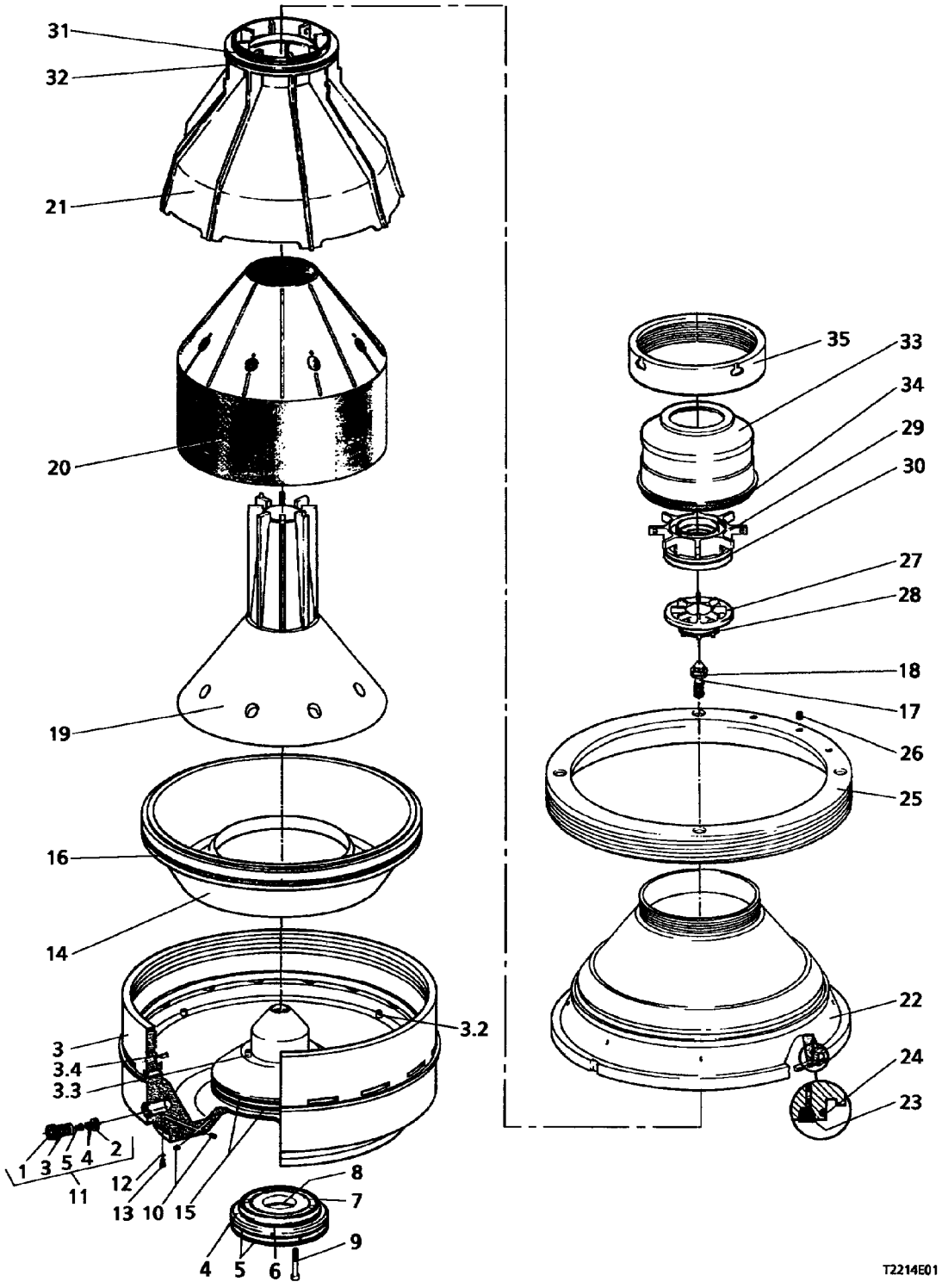

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Fig.196

Pos.	Part-No.	Qty.		Part description	Dimensions
	2294-6600-L			**Bowl, complete**	
3	2263–6604–L	1	1)	Bowl bottom, complete	
3.2	0026–5690–400	3		- Cylindrical pin DIN 7	12H8x32
3.3	0026–1137–400	3		- Cylindrical pin DIN 7	14H8x40
3.4	0026–0695–400	1		- Lug	12x12x15
4	see page 150	1		Ring	
5	0007-2707-750	2		Gasket	225X3
6	0007-2766-750	1		Gasket	192X3
7	0007-2940-750	1		Gasket	140X4
8	0007-2601-750	1		Gasket	80X4,5
9	0019-6150-400	3		Allen screw DIN 912	M10X55
10	0019-6324-400	4		Threaded pin DIN 913	M10X10
11	see page 151	2		Valve	
12	0004-2288-400	2		Gasket	U7,3X10,2X1
13	0019-8338-300	2		Cylindrical screw DIN 6912	M6X10
14	2263-6501-020	1	1)	Sliding piston	
15	0007-2424-760	2		Gasket	309X325X8
16	0007-2964-760	1		Gasket	636X660X12
17	0019-0339-400	1		Spindle screw	M22X1,5-LH
18	0007-1943-750	1		Gasket	32,2X3
19	2295-6620-L	1	1)	Distributor	
20	2263-6600-L	1		Disk stack	
21	2294-6650-010	1	1)	Separating disk	
22	2263-6611-000	1	1)	Bowl top	
23	0007-1789-840	1		Gasket	639,5X16,5
24	0007-1756-760	1		Gasket	665X5
25	3287-6631-L	1	1)	Lock ring	S755X14-LHAG
26	0019-6346-400	6		Threaded pin DIN 913	M16X20
27	2295-6645-010	1		Centripetal pump chamber cover	
28	0007-2608-750	1		Gasket	85X3,5
29	2295-6645-000	1		Centripetal pump chamber cover	
30	0007-2942-750	1		Gasket	155X4
31	0007-2575-750	1		Gasket	233X3
32	0007-2732-750	1		Gasket	265X4
33	2263-6642-020	1		Centripetal pump chamber cover	
34	0007-2577-750	1		Gasket	275X4,5
35	3014-6631-020	1		Lock ring	TR310X14-LHIG

1) This part can only be replaced by one of our service engineers or in one of our workshops because of special fitting to the machine.

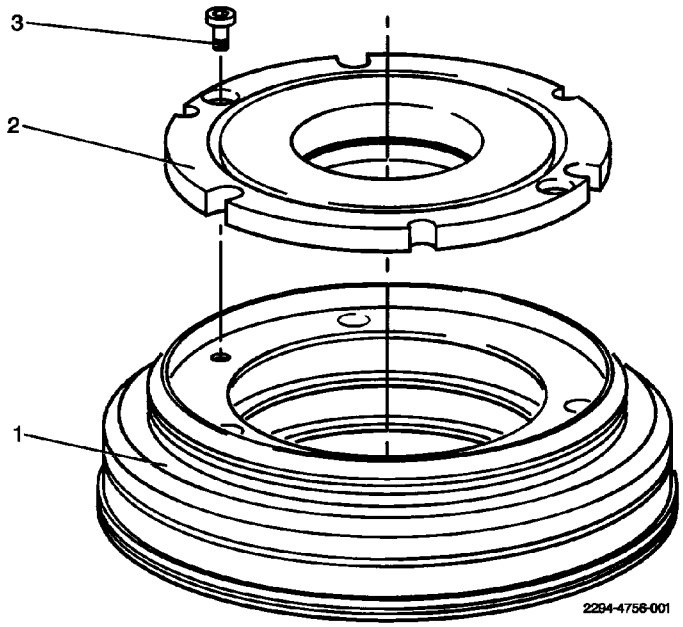


Fig.197

Pos.	Part-No.	Qty.		Part description	Dimensions
	2294-6597-010			**Ring, compl.**	
1	2294-6597-000	1		Ring	
2	2294-6598-010	1		Ring	
3	0019-8339-400	2		Cylindrical screw DIN 6912	M6X12

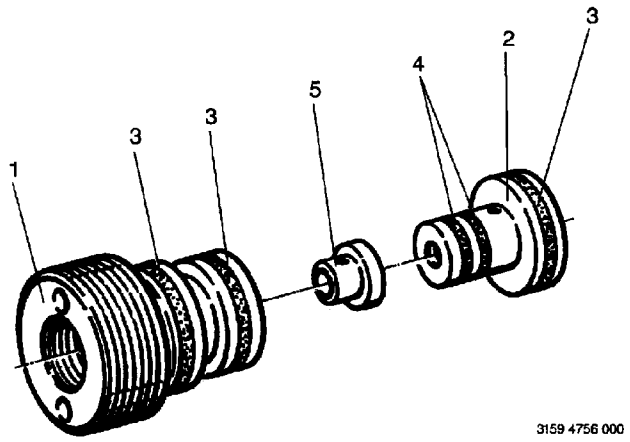


Fig.198

Pos.	Part–Number	Qty.		Part description	Dimensions
	3159-6280-040			**Valve, compl.**	
1	3159-6281-000	1		Valve housing	
2	3159-6276-010	1		Valve piston	
3	0007-2920-760	4		Gasket	23,3X2,4
4	0007-2923-760	2		Gasket	9,3X2,4
5	0004-2341-940	1		Gasket	6X9,9X10,5
6	3159-6200-000	1		Set of joint rings	F.ERSATZ

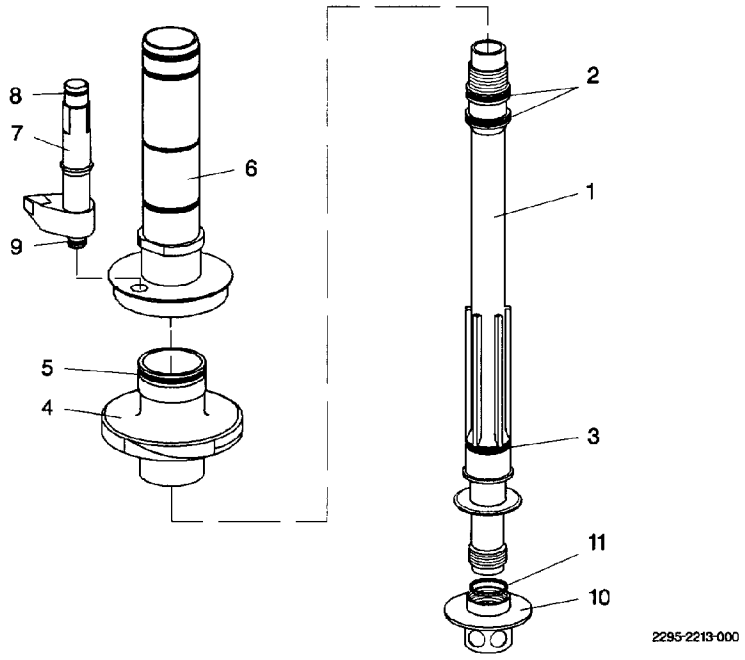


Fig.199

Pos.	Part-No.	Qty.		Part description	Dimensions
	2295-2213-010			**Double centripetal pump, cpl.**	
1	2295-2246-000	1		Feed tube	
2	0007-1907-750	2		Gasket	49X3,5
3	0007-2597-750	1		Gasket	50X4
4	2295-2241-000	1		Lower centripetal pump	
5	0007-1735-750	5		Gasket	60X3
6	2295-2239-000	1		Distance sleeve	
7	2295-2252-000	1		Upper centripetal pump	
8	0007-2989-750	1		Gasket	20,3X2,4
9	0007-2926-750	1		Gasket	15,3X2,4
10	2295-2304-000	1		Sealing disk	
11	0007-1757-700	1		Gasket	40X4

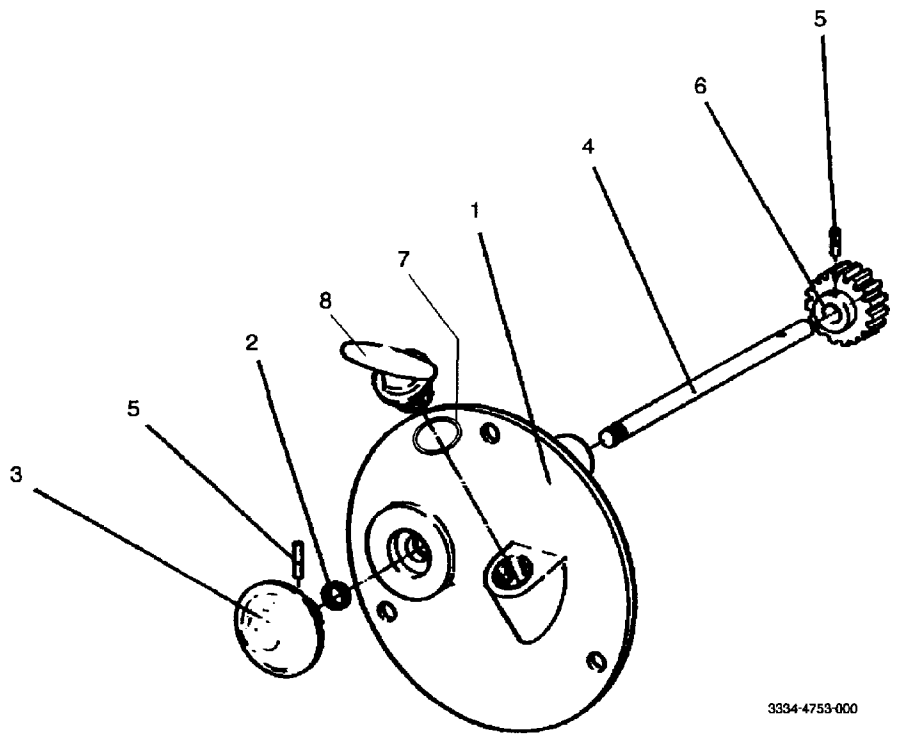


Fig.200

Pos.	Part-No.	Qty.		Part description	Dimensions
	3334-3495-000			**Revolution indicator, complete**	
1	3170-3493-000	1		Revolution indicator housing	
2	0004-5523-750	1		Sealing ring DIN 3760	A12X22X7
3	3117-3497-010	1		Revolution indicator disk	
4	3170-3488-010	1		Shaft	
5	0026-1049-030	2		Cylindrical pin ISO 2338	B-3X24
6	3117-3487-010	1		Worm wheel	
7	0004-1883-720	1		Gasket	26.5X35X2
8	0018-5481-000	1		Wet-air filter	0.2CBM/MIN-M26X1.5

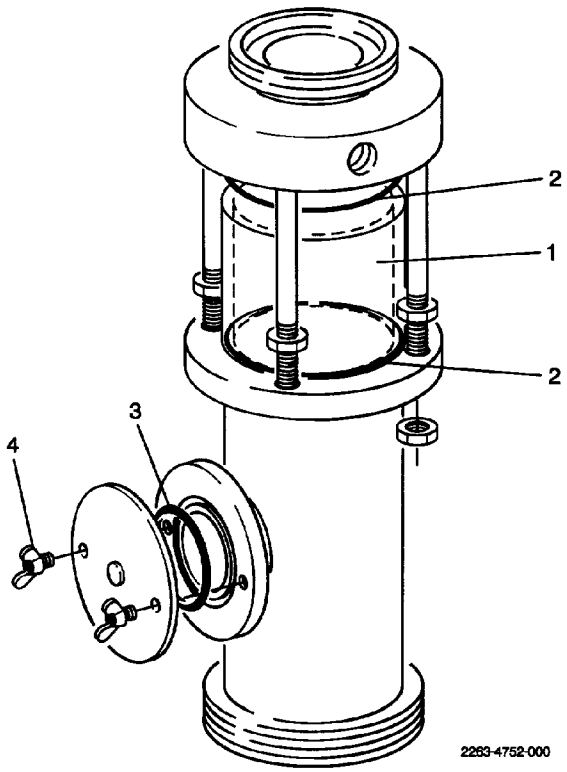


Fig.201

Pos.	Part-No.	Qty.		Part description	Dimensions
	2263-2390-000			**Sight glass frame compl.**	
1	0001-0115-820	1		Cylinrical sight glass	110X5X115
2	0007-2750-750	2		Gasket	100X112X6
3	0007-2211-750	1		Gasket DIN 11851	G50
4	0019-3715-300	2		T-screw DIN 316	M10X15

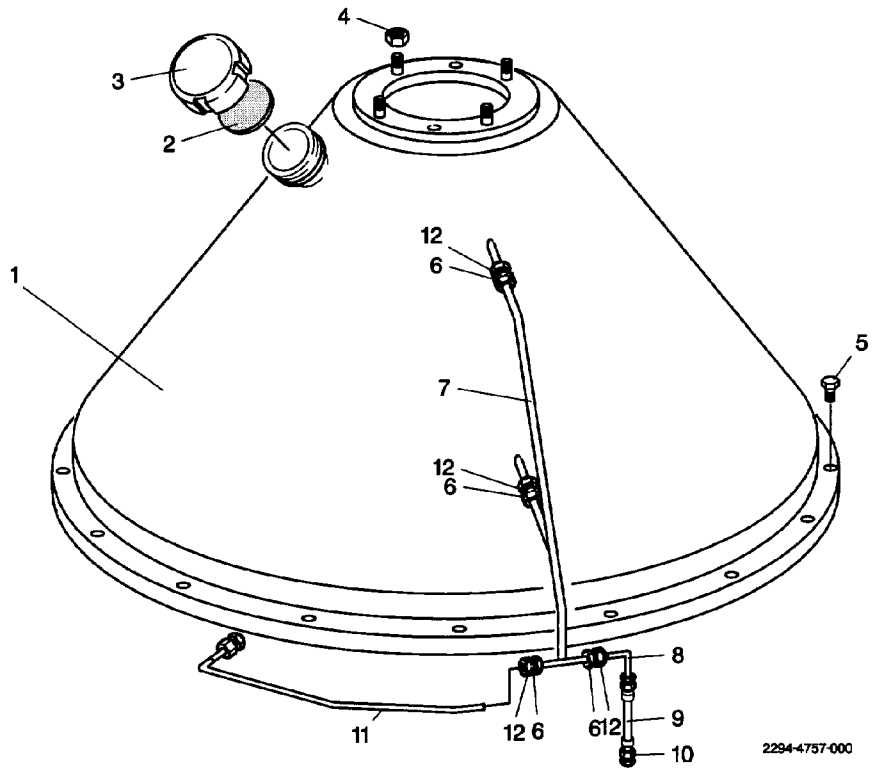


Fig.202

Pos.	Part-No.	Qty.		Part description	Dimensions
	2294-7759-010			**Hood, complete**	
1	2294-7765-000	1		Hood	
2	0004-1757-750	1		Gasket	65x3
3	0013-3297-300	1		Blind nut	40
4	0013-0280-400	4		Hexagon nut ISO 4032	M 12
5	0019-6966-400	16		Hex head screw ISO 4017	M12X20
6	0018-1697-400	4		Welding union	ASK512-S
7	2294-7448-010	1		Pipe	
8	2294-7448-000	1		Pipe	
9	0018-6250-400	1		Low-pressure hose	8X850
10	0018-3462-400	1		Union DIN 2353	DS12-R1/2
11	2294-7471-000	1		Pipe	
12	0007-2003-750	4		Gasket	9x1.5

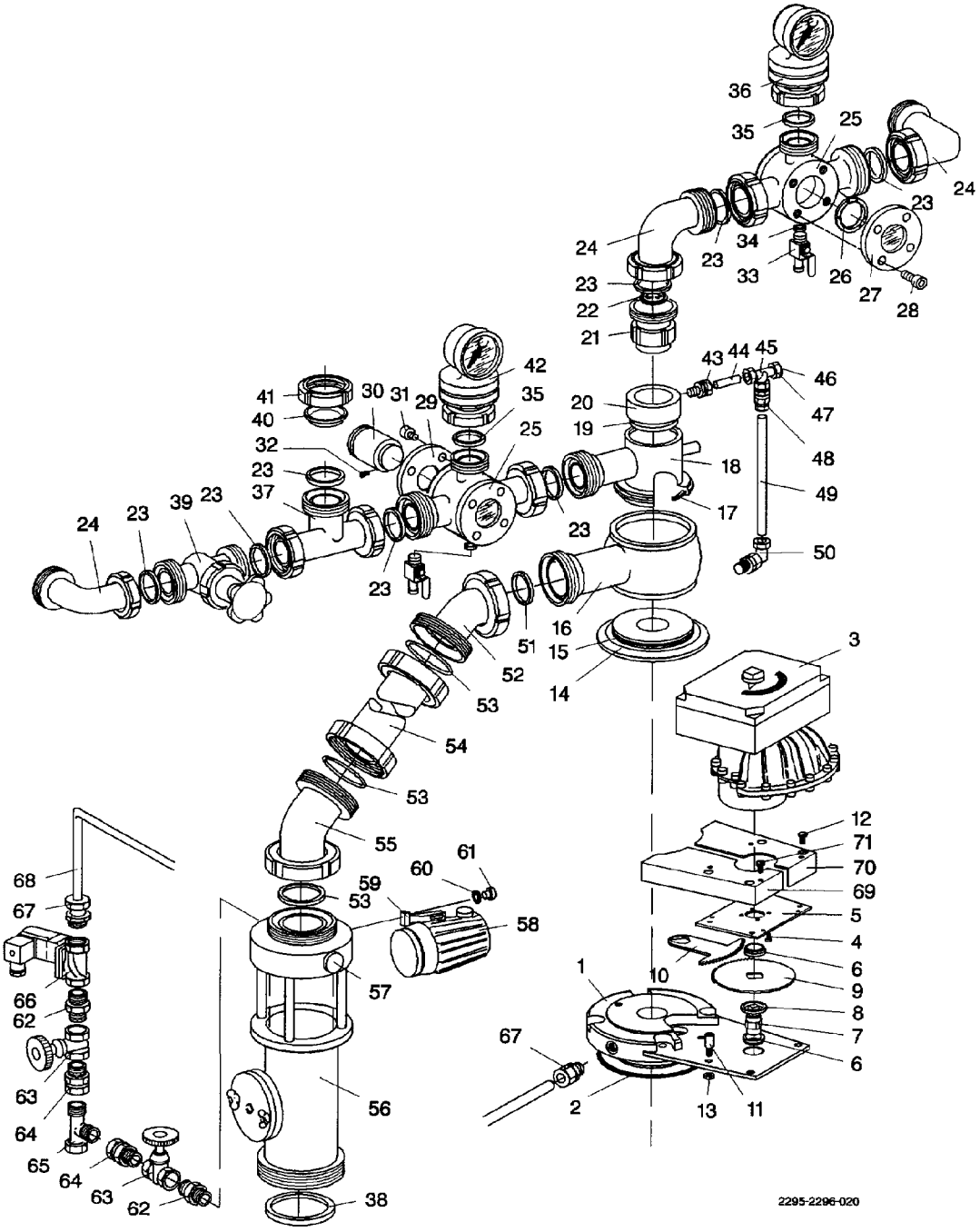

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Fig.203

Pos.	Part-No.	Qty.		Part description	Dimensions
	2295-2296-020			**Feed and discharge connections, cpl.**	
10	2295-2218-020	1		Ring	
20	0007-2564-750	1		Gasket	170X3
30	0021-2980-100	1		Swivel–type actuator	90GRAD
40	0019-6106-400	4		Allen screw DIN 912	M6X16
50	2295-2467-010	1		Plate	
60	2295-2239-010	2		Sleeve	
70	2295-1096-000	1		Welle	
80	2295-2247-000	1		Disk	
90	2295-2947-000	1		Toothed quadrant	
100	2295-2947-010	1		Toothed quadrant	
110	0019-1173-400	4		Stud bolt	M8X24,5
120	0019-6901-400	4		Hex head screw ISO 4017	M8X16
130	0013-0278-300	4		Hexagon nut ISO 4032	M 8
140	2295-2218-010	1		Ring	
150	0007-2642-750	1		Gasket	132X3
160	2263-2285-010	1		Lower discharge	
170	0007-2649-750	1		Gasket	118X4
180	2295-2286-000	1		Upper discharge	
190	0007-2014-750	1		Gasket	75X4
200	2295-2011-000	1		Vent piece	
210	3222-2189-000	1		Connection piece	
220	0007-3281-750	1		Gasket	42X4
230	0007-2211-750	10		Gasket DIN 11851	G50
240	0018-1626-400	3		Bend DIN 11852	BB-90-50
250	0001-1304-410	2		Sight glass housing	50
260	0007-2487-830	4		Gasket	57X4
270	0001-0273-820	4		Sight glass disk	50
280	0019-6164-400	8		Allen screw DIN 912	M12X25
290	0005-4131-310	2		Flange	DN50
300	0005-4129-300	2		Sight glass lamp	KVLR05HSP2-12VAC-5W
310	0019-8386-400	8		Cylindrical screw DIN 6912	M12X30
320	0019-2217-300	2		Cylindrical screw ISO 1207	M4X8
330	0018-1526-400	2		Hose cock	G1/2IN
340	0007-2102-750	2		Gasket	10,5X18X5
350	0007-2210-750	2		Gasket DIN 11851	G40
360		1	1)	Pressure gauge	
370	0018-4252-400	1		T–piece DIN 11852	TC50
380	0007-2522-750	1		Gasket DIN 11851	G100
390	0018-6554-400	1		Throttle valve	50
400	0001-0264-400	1		Blind cap	50
410	0013-2845-300	1		Grooved coupling nut DIN 11851	F50
420		1	1)	Pressure gauge	
430	0018-3465-400	1		Union DIN 2353	DL8
440	000029-117-40	1		Pipe ISO 1127	8X1x85

1) This part is order–specific and can be ordered stating the serial number of the machine.

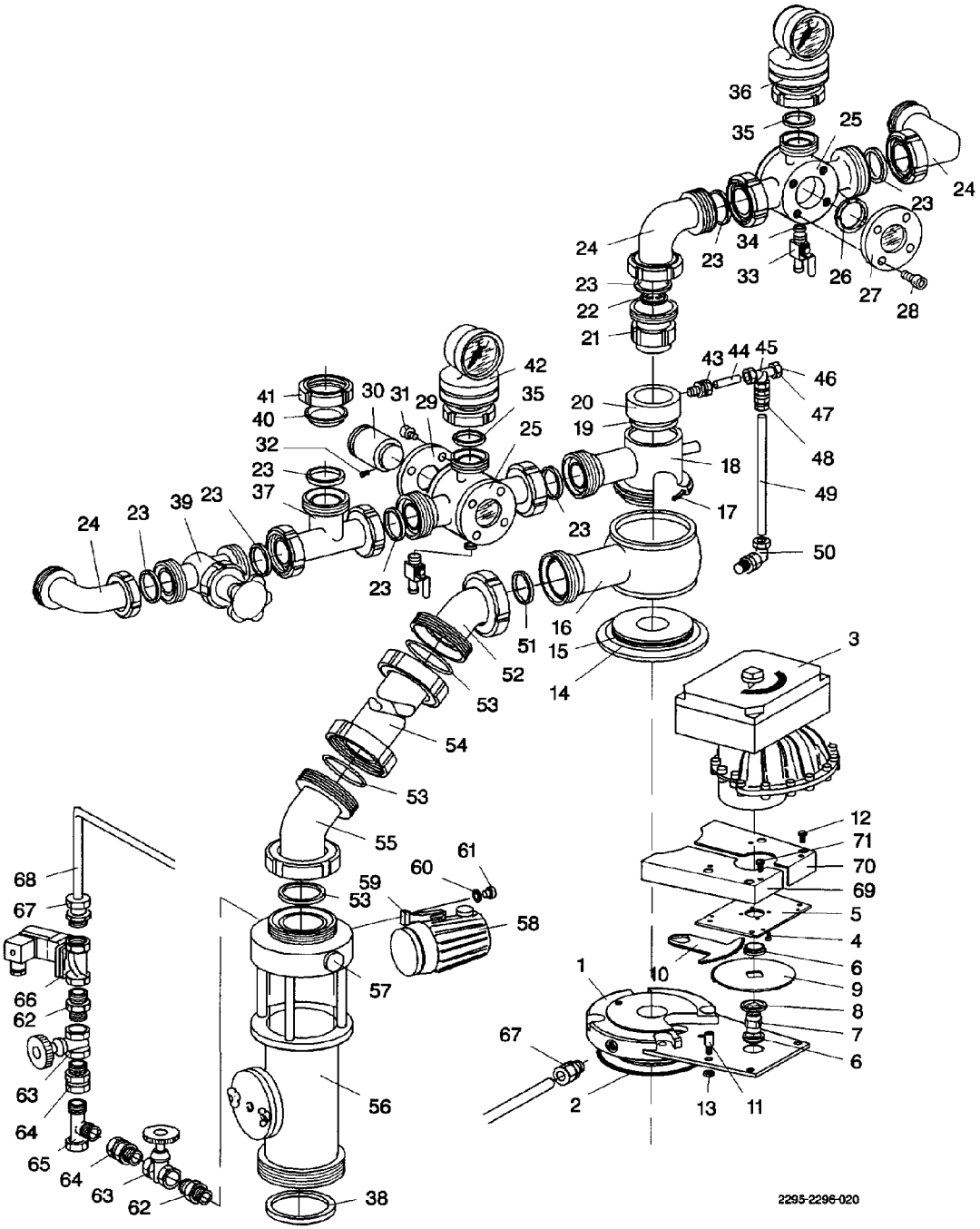

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Fig.204

Pos.	Part-No.	Qty.		Part description	Dimensions
450	0018-3534-400	1		Adjustable T-connection piece	EVT8-L
460	0018-3199-400	1		Sealing nipple	BUZ-8-L
470	0013-1999-400	1		Coupling nut DIN 3870	AL8
480	0018-3481-400	1		Non–return valve	RHD8-PL
490	000029-117-40	1		Pipe ISO 1127	8X1x170
500	0018-3355-400	1		Adjustable angular screw coupling	EVW8-PLR
510	0007-2212-750	1		Gasket DIN 11851	G 65
520	0018-5669-400	1		Pipe bend	45-80-65
530	0007-2520-750	3		Gasket DIN 11851	G80
540	2226-2166-000	1		Connecting pipe	
550	0018-5668-400	1		Pipe bend	45-80-80
560	see page 154	1		Lantern	
570	0019-1682-300	1		Threaded plug	G1/2INAX10
580	0005-3474-000	1		Sight glass lamp	24V-20W
590	0005-3474-300	1		Hinge	
600	0026-1325-300	1		Lock washer DIN 127	B8
610	0019-6119-400	1		Allen screw DIN 912	M8X12
620	0018-0965-400	2		Double nipple	R1/2IN
630	0018-1408-690	2		Socket gate valve	1/2IN
640	0018-3275-400	2		Screwed socket	EVGE15-PLR-ED
650	0018-3248-400	1		T-union DIN 2353	QL15
660		1	1)	Solenoid valve	
670	0018-3469-400	2		Union DIN 2353	DL15
680	000029-158-30	1		Pipe	15X2x2500
690	2295-2356-000	1		Guard half	
700	2295-2356-010	1		Guard half	
710	0019-6900-300	4		Hex head screw ISO 4017	M8X12

1) This part is order–specific and can be ordered stating the serial number of the machine.

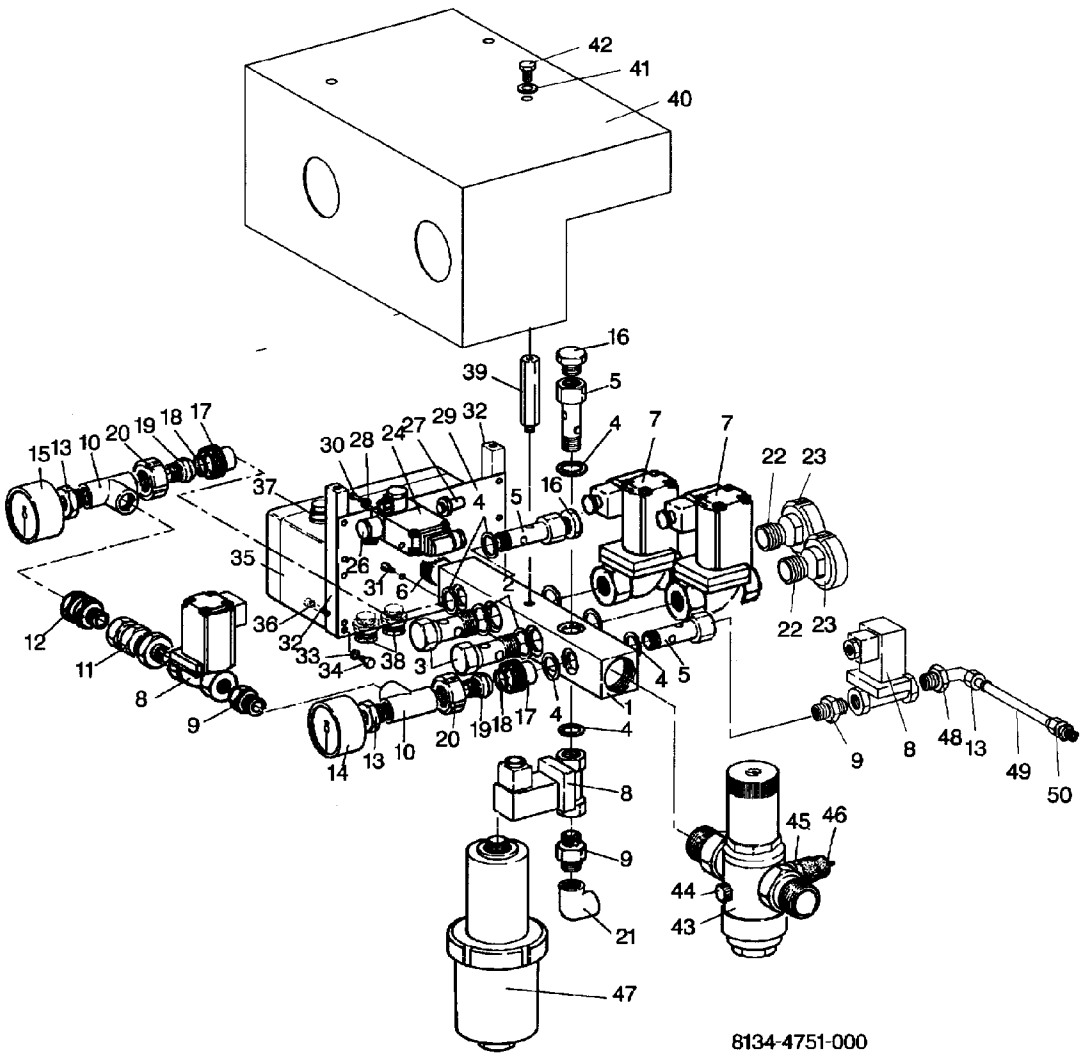

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Fig.205

Pos.	Part-No.	Qty.		Part description	Dimensions
–	**8134-2105-330**			**Operating water connection, cpl.**	
1	8134-2319-100	1		Distributor	
2	0004-5982-300	4		Gasket	U 28,7x35x2
3	8134-2161-040	2		Screw	
4	0004-2891-300	6		Gasket	U 22,7x30x2
5	8134-2161-050	3		Screw	R1/2in
6	0019-0653-400	1		Threaded plug	R1in x20
7		2	1)	Solenoid valve	
8		3	1)	Solenoid valve	
9	0018-0965-400	3		Double nipple	R1/2in
10	0018-0116-400	2		T-piece DIN 2987	1/2in
11	0018-5936-400	1		Non-return valve	RHV16-PSR-ED-OMD
12	0018-4819-400	1		Screwed socket	EVGE16-PSR-ED
13	0018-5168-400	3		Reducing connection	RI 1/2x1/4
14	0001-0299-610	1		Pressure meter DIN 16063	0-6,0 bar
15	0001-1196-400	1		Pressure meter DIN 16063	0-16 bar
16	0019-0559-300	2		Threaded plug	R1/2in x15
17	0018-5937-400	2		Screw-on threaded connection	15-R1/2in
18	0007-2521-750	2		Gasket DIN 11851	G 15
19	0018-6236-400	2		Threaded cone connection	15-R1/2in
20	0013-2840-300	2		Grooved coupling nut DIN 11851	F15
21	0018-0004-300	1		Angle piece DIN 2987	1/2in
22	0018-5286-400	2		Threaded cone connection	25-R3/4in
23	0013-2842-300	2		Grooved coupling nut DIN 11851	F25
24		1	1)	Solenoid valve	
26	0018-3732-280	2		Angular hose screw coupling	G1/4in-6x8,3
27	0018-1371-600	1		Silencer	6
28	0026-1877-300	4		Washer	5,5x12x1,5
29	8134-2208-150	1		Plate	
30	0019-2376-300	4		Cheese-head screw ISO 1207	M4x16
31	0019-6840-400	4		Hex head screw ISO 4017	M6x12
32	8134-2059-040	2		Distance piece	
33	0026-1382-300	5		Washer DIN 125	6,4
34	0019-6841-300	5		Hex head screw ISO 4017	M6x16
35		1	1)	Terminal box	
36	0019-6111-400	4		Allen screw DIN 912	M6x30
37	0005-0203-900	15		Screw coupling	PG11x5-10
38	0005-0206-900	3		Screw coupling	PG21x13-18
39	8134-2059-030	1		Distance piece	
40	8134-2355-090	1		Protective casing	
41	0026-0439-300	3		Washer	8,4x24x2
42	0019-6900-300	3		Hex head screw ISO 4017	M8x12
43	0018-1742-650	1		Water pressure reducer	1 1/4in-16/1,5-6 bar
44	0019-1492-400	1		Threaded plug	R1/4
45	0005-4111-010	1		Pressure switch	1,0-10,0 BAR-4A
46	0005-4111-890	1		Coupler socket	250V AC -4A
47	see page 162	1		Metering cylinder	
48	0018-2483-400	1		Angular screw coupling DIN 2353	GL 8
49	0018-1870-310	1		Low-pressure hose	N1BE8-L-600
50	0018-3465-400	1		Screw coupling DIN 2353	DL8

1) This part is order-specific and can be ordered stating the serial number of the machine.

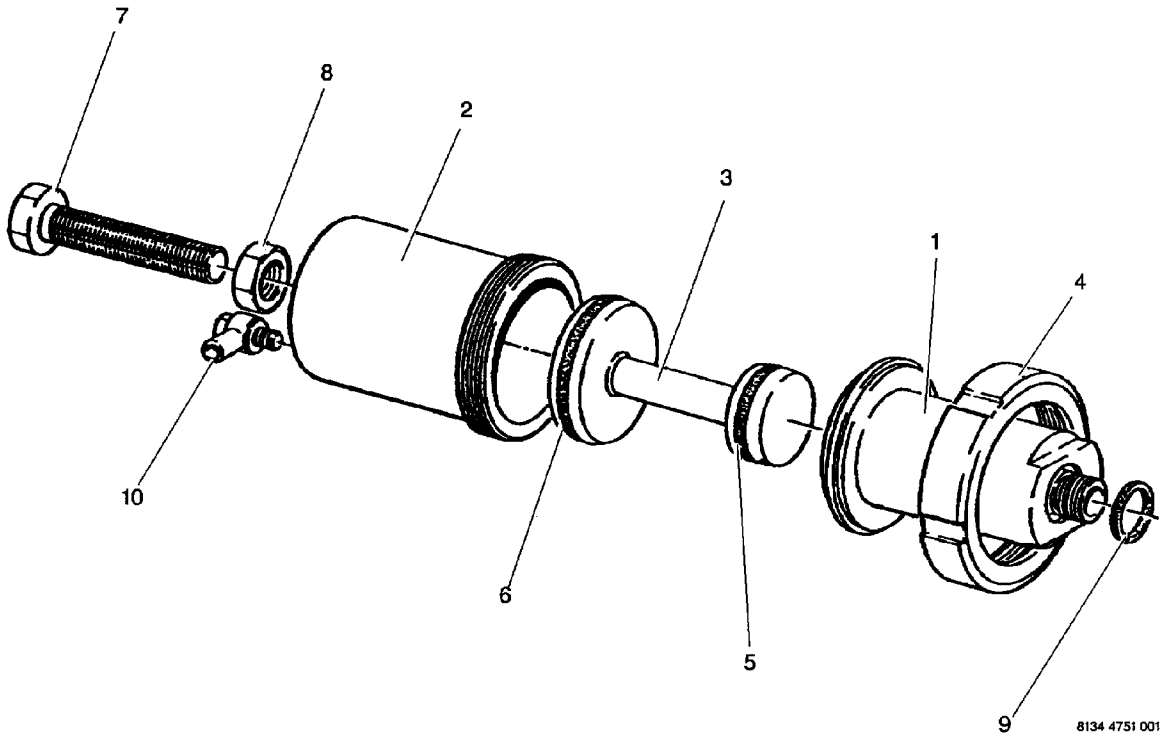


Fig.206

Pos.	Part-No.	Qty.		Part description	Dimensions
–	**8134–2202–030**			**Metering cylinder, complete**	
1	8134–2311–130	1		Housing	
2	8134–2311–140	1		Housing	
3	8134–2279–030	1		Piston	
4	0013–2846–300	1		Grooved coupling nut DIN 11851	F65
5	0007–3202–750	1		Gasket	43,8x54,46x5,33
6	0007–3203–750	1		Gasket	69,2x79,86x5,33
7	0019–9435–400	1		Hex head screw ISO 8676	M20x1,5x100
8	0013–0319–400	1		Hexagon nut DIN 936	M20x1,5
9	0007–1941–750	1		Gasket	25x2,5
10	0018–3732–280	1		Angular hose screw coupling	G1/4in–6x8,3

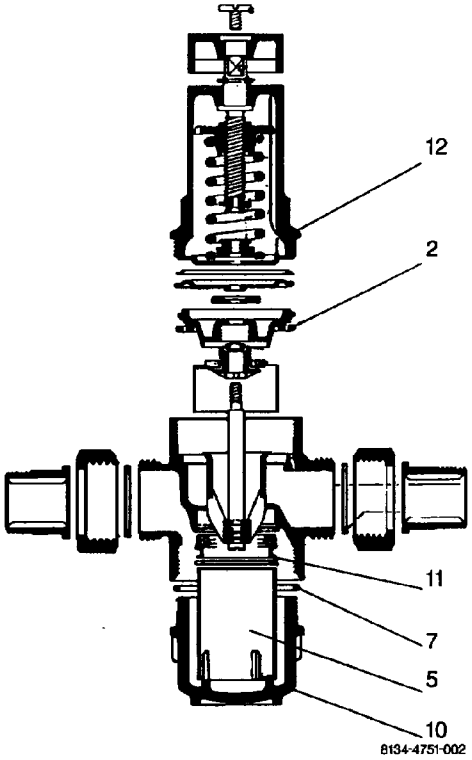


Fig.207

Pos.	Part-No.	Qty.		Part description	Dimensions
–	**0018–1742–650**			**Water pressure reducer 16/1,5–6 bar**	1 1/4in
2	0007–1907–750	1		Gasket	49x3,5
5	0018–1741–030	1		Single strainer	1in–1 1/4in
7	0007–2929–750	1		Gasket	55,2x3
10	0018–1741–610	1		Strainer plug	1in
11	0018–1741–620	1		Grooved ring holder	1in
12	0018–1741–040	1		Spring retainer	1in
–	0018–1741–100	1		Valve case, compl.	1in

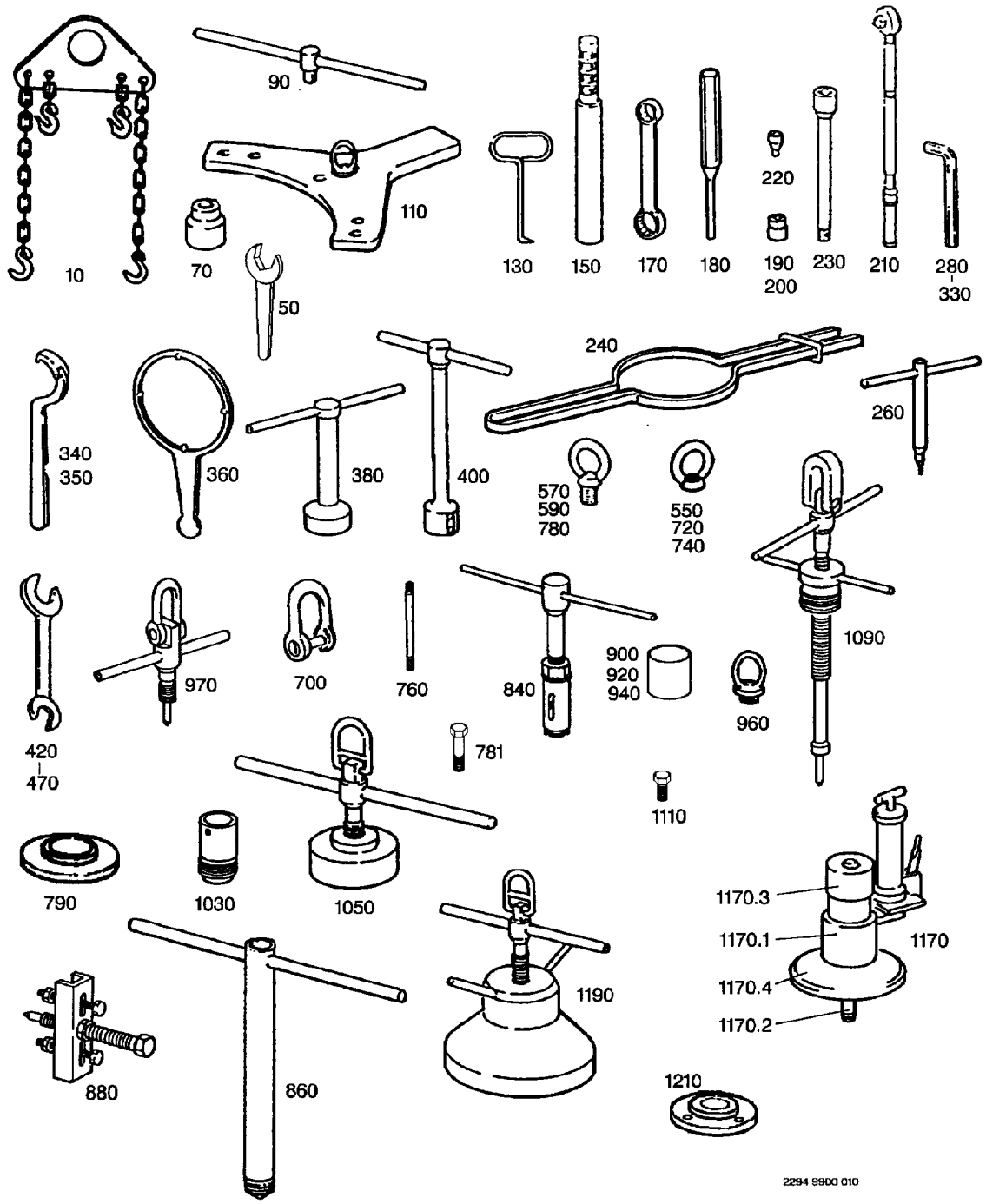

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Fig.208

Pos.	Part-No.	Qty.		Part description	Dimensions
	2294-9900-010			**Set of tools**	
10	0003-0065-030	1		Lifting device (bowl lock ring/distributor/ hood) DIN 939	350KG
50	0003-0085-320	1		Single–ended wrench DIN 894 (discharge on top)	65
70	0003-0094-320	1		Socket (bowl)	60X20
90	0003-0095-320	1		T–handle DIN 3122 (bowl)	A20
110	0003-0539-030	1		Pin spanner (bowl lock ring) DIN 939	594,2X20
130	0003-0156-000	1		Hook (bowl bottom)	180X27
150	0003-0200-000	1		Mallet (lock ring)	42x420
170	0003-0480-320	1		Wrench DIN 837	17X19
180	0003-0574-000	1		Pin punch DIN 6450	C4
190	0003-0579-320	1		Socket DIN 3124	17X12,5
200	0003-0581-320	1		Socket DIN 3124	22X12,5
210	0003-0590-000	1		Torque wrench	20BIS150NM
220	0003-0601-320	1		Hexagon socket	8
230	0003-0615-000	2		Extension DIN 3123	B12,7X250
240	0003-3487-170	1		Lifting tongs (centripetal pump chamber cover)	270
260	0003-3727-030	1		Wrench (bowl valve)	M4
280	0003-3774-320	1		Allen wrench DIN 911	4
290	0003-3775-320	1		Allen wrench DIN 911	5
300	0003-3776-320	1		Allen wrench DIN 911	6
310	0003-3777-320	1		Allen wrench DIN 911	8
320	0003-3780-320	1		Allen wrench DIN 911	14
330	0003-3791-320	1		Screwdriver DIN 6911	8
340	0003-3845-000	1		Pivoted hook wrench	60-90
350	0003-3846-000	1		Pivoted hook wrench	90-155
360	0003-4041-030	1		Annular wrench	336
370	0000-0009-013	1		(centripetal pump chamber lock ring) DIN 939	
380	0003-4175-030	1		Socket wrench (pressure piece)	60
400	0003-4193-030	1		Socket wrench (spindle screw)	24
420	0003-4202-320	1		Wrench DIN 3110	10X13
430	0003-4204-320	1		Wrench DIN 3110	16X18
440	0003-4205-320	1		Wrench DIN 3110	17X19
450	0003-4208-320	1		Wrench	22X27
460	0003-4209-320	1		Wrench DIN 3110	24X30
470	0003-4222-320	1		Wrench DIN 3110	36X41
550	0013-0388-030	2		Lifting–eye nut DIN 582 (hood)	M 12
570	0019-5383-050	2		Eye bolt DIN 580 (feed and discharge connections)	M 12
590	0019-5384-050	1		Eye bolt DIN 580 (bowl lock ring)	M16
700	0026-0253-030	2		Shackle DIN 82101 (separating disk)	B0,4
720	0013-0386-030	2		Lifting–eye nut DIN 582 (operating–water feeding system)	M 8

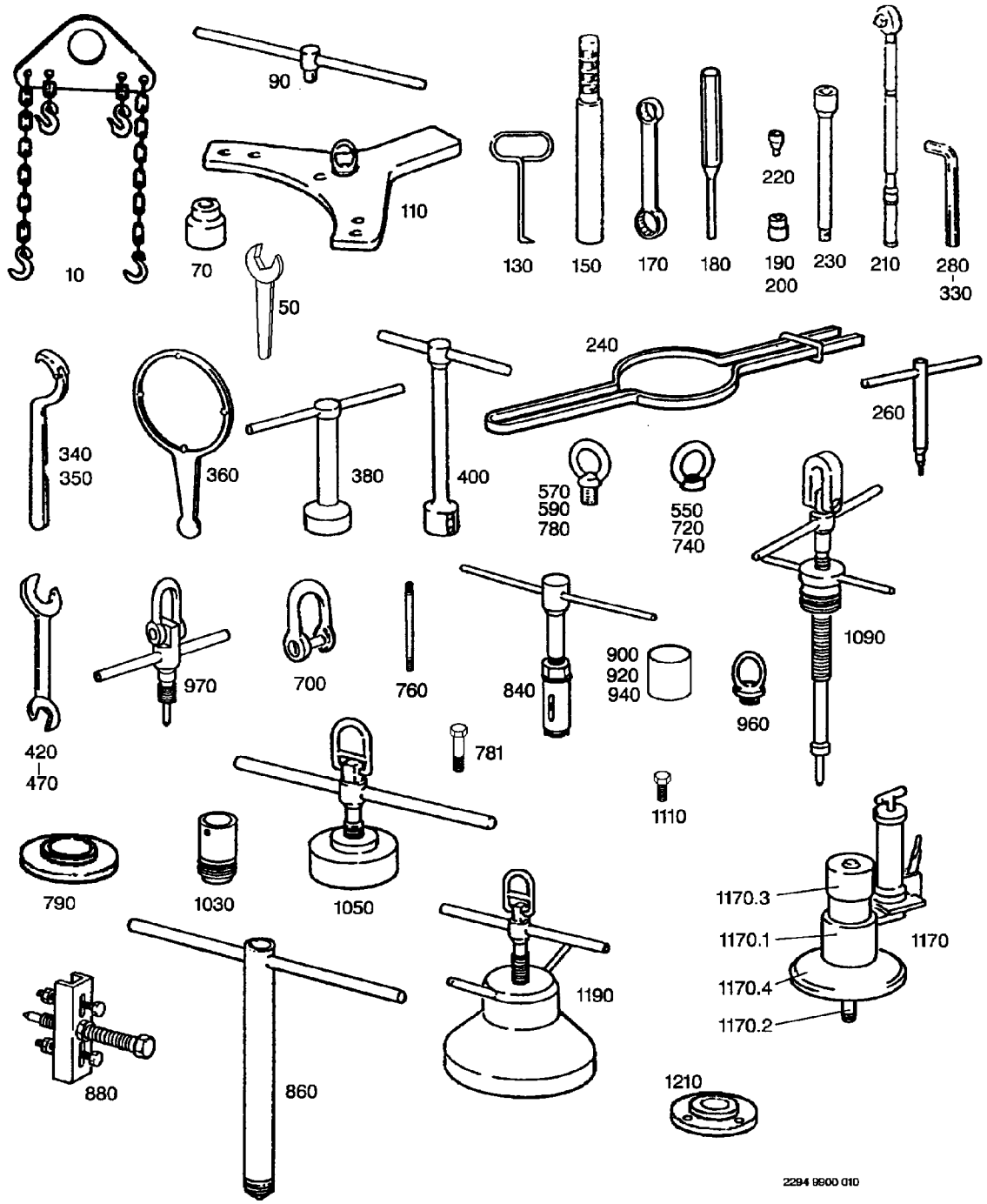
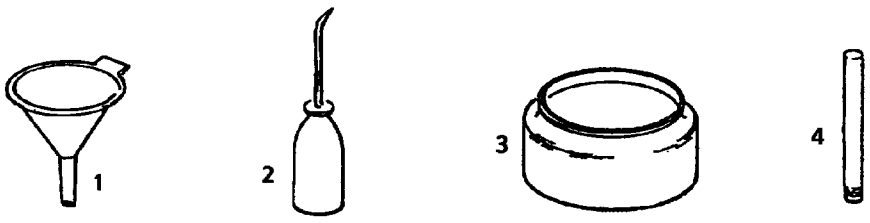

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Fig.209

Pos.	Part-No.	Qty.		Part description	Dimensions
740	0013-0388-030	2		Lifting–eye nut DIN 582 (hood)	M 12
760	0019-0689-090	2		Threaded spindle (operating–water feeding system)	M8-M8X205
780	0019-5384-050	2		Eye bolt DIN 580	M16
781	0019-6989-150	2		Hex head screw ISO 4017 (feed and discharge connections)	M12X150
790	0026-1829-030	1		Centering disk (sealing ring/operating–water feeding system)	25X145
840	1165-9895-010	1		Socket wrench (bowl valve)	
860	1166-9910-010	1		Puller (clutch/brake pulley)	
880	1171-9910-000	1		Pulling device (cam hub)	
900	1313-9868-000	1		Sleeve (sealing ring/operating–water feeding system)	
920	1313-9868-010	1		Sleeve (sealing ring/operating–water feeding system)	
940	1313-9868-020	1		Sleeve (sealing ring/operating–water feeding system)	
960	1231-9862-000	1		Spindle lifter	
970	1231-9930-070	1		Jack (bowl bottom)	
1030	2263-9806-000	1		Pressure piece (bowl top)	
1050	2263-9850-000	1		Lifting device (bowl top)	
1090	2263-9970-000	1		Lifting device (distributor)	
1110	2294-1161-000	2		Puller screw (protective housing)	M8X35
1170	3287-9820-000	1		Compressing device, compl. (disk stack compressing device) DIN 939	
1170.1	1235-9851-000	1		- Threaded ring	
1170.2	1235-9770-000	1		- Hydraulic part	
1170.3	3287-9877-000	1		- Threaded bolt	
1170.4	3287-9939-000	1		- Disk	
1190	3287-9960-000	1		Lifting device (sliding piston) DIN 5406	
1210	3347-9861-000	1		Mounting device (ball bearing)	

The tools delivered are stated in the packing list.



W1313E02

Fig.210

Pos.	Part-No.	Qty.		Part description	Dimensions
–	**1313–9901–000**			**Set of accessories**	
1	0003–0168–890	1		Funnel	140
2	0003–0256–890	1		Force–feed oiler	250 cm^3
3	0003–0277–800	1		Oil collecting pan	2,7 l
15	0015–0014–080	5		Lubricating oil CLP220 (dangerous substance)	2,5 l
16	0015–0050–090	2		Lubricating oil DIN 51515 L–TD32 (dangerous substance)	5L
17	0015–0121–000	1		Ball and roller bearing grease DIN 51825 K3K	0,85 kg
18	0015–0113–020	4		Lubricating grease KSB8 dangerous substance)	50 g
26	0018–3430–030	1		Pipe	M22x1,5x200

The tools delivered are stated in the packing list.

NOTE - THIS INSTRUCTION SHEET APPLIES ONLY TO NON INTRINSICALLY SAFE MODELS. IF YOUR APPLICATION IS IN AN AREA WITH AN EXPLOSION HAZARD, DO NOT USE THE THREE AND FOUR TERMINAL MODELS DESCRIBED HERE.

1. CONTENTS.

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1	1. Contents.
2	2. Installation - 2.1 Direct Mounting Units onto Kinetrol Positioner Actuators
2	2.2 Mounting of Discrete Positioners
3	2.3 Air and Electrical Connections (3-Terminal Models)
4	3. Schematic Functional Diagram (3-Terminal Models)
4	4. Setup - Diagram and General (3-Terminal Models)
5	" (1) Travel Speed.
5	" (2) Smoothness and Sensitivity.
5	" (3) Span and Zero.
5	" (4) Optional Limit Switch Cams.
5	5. Converting CW / ACW Sense of Positioner (3-Terminal Models)
6	6. Maintainance and Troubleshooting.
7	7. Isolated Angle Retransmit Option (4-Terminal Models).
7	7.1 Description (4-Terminal Models).
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2. INSTALLATION

Positioners can be supplied direct-mounted, or ready to be direct-mounted, onto Kinetrol rotary actuators, or in stand-alone (discrete) form for fitting via a mount kit to any 90 degree rotary actuator. If the positioner is supplied ready mounted on an actuator, sections 2.1 and 2.2 can be bypassed. Positioner-type Kinetrol actuators (ready for direct mounting of positioners) are available in models 03 to 14 inclusive.

2.1 Mounting of Direct Mounting Units onto Kinetrol Positioner-Type Actuators

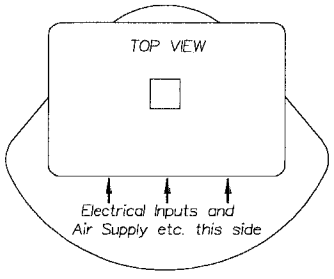


FIGURE 1. Mid Travel Orientation of Actuator Square and Positioner Box.

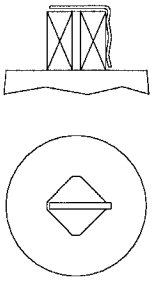


FIGURE 2. Location of Anti-Backlash Spring on 07 & Larger Squares.

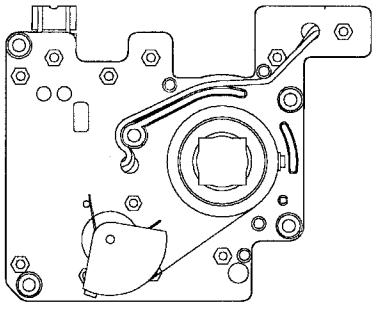


FIGURE 3. Bottom View of Carrier Plate Assembly Showing Shaft and Potentiometer in Mid Travel, Ready to be Fitted to Actuator in Mid Travel.

(1) Move actuator vane to mid travel position, with its output square as shown in Figure 1. This is essential to prevent subsequent error in orienting positioner square.
(2) Remove positioner cover, and undo the five M4 slot-headed screws holding the red plastic carrier plate into the body. Disconnect the two wires to the servo valve, and lift out the whole carrier plate assembly complete with shaft and circuit etc.
(3) Bolt the positioner body to the actuator in the orientation shown in Figure 1, taking care that O-rings are in place to seal the ports into the actuator, and that the actuator shaft is centred in its hole.
(4) On 07 and larger models, fit anti-backlash spring over one corner of the actuator square as shown in Figure 2.
(5) Observe the range of motion available to the positioner shaft, limited by the correct running of the potentiometer quadrant wheel, driven by the stainless steel strap (see Figure 3). Fit the carrier plate/shaft assembly back into the positioner box with the shaft near mid-range, "feeling" the female square in the positioner shaft onto the male actuator square while maintaining its position near mid range. It is essential that the two shafts are correctly oriented relative to each other, since if they are 90 degrees out, the quadrant wheel can be forced too far and damage done to the drive mechanism during subsequent actuator movements. It is possible to fit the positioner correctly with the actuator square at one end of its travel, but experience indicates a high probability of mistaking the direction of movement of the actuator - hence it is strongly advised that the positioner be fitted with the actuator square at the mid-travel position, where there is no ambiguity possible.

2.2 Mounting of Discrete Positioner

Design and manufacture of the mount kit between positioner and actuator is outside the scope of this document. It is essential that the shaft of the actuator is well aligned with the positioner shaft, and that the two are coupled together with a minimum of backlash - any backlash acts to deteriorate the performance of the positioner/actuator combination.

It is also essential that the 90 degree travel of the actuator moves the positioner shaft through the correct 90 degree range of travel. The easiest way to ensure that this happens is to mount the discrete unit with the lid and indicator in place - set both the actuator and positioner to mid travel, and mate the two in this orientation. Don't take any chances with this, since misorientation of the positioner shaft and consequent movement beyond its designed range of travel will probably result in damage to the positioner pot drive mechanism.

2.3 Air and Electrical Connections (3 terminal models).

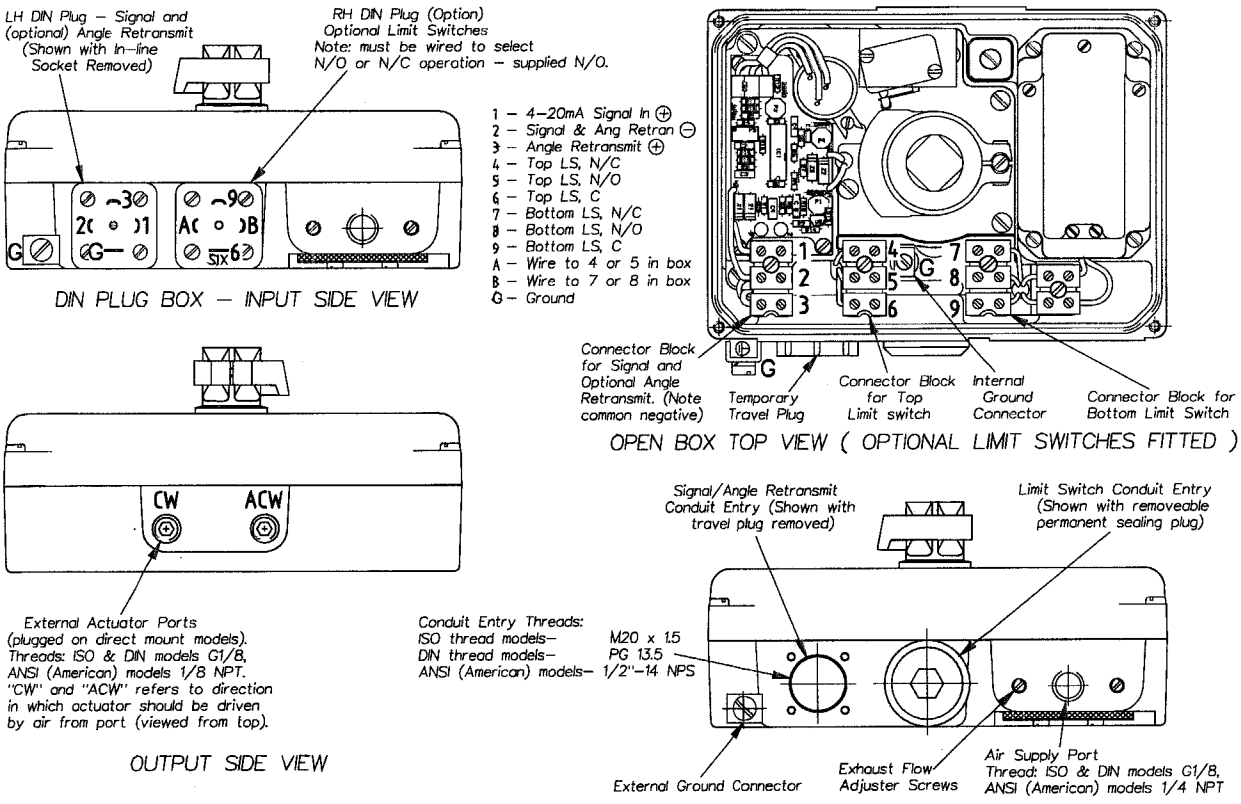


FIGURE 4. EXTERNAL CONNECTIONS

NOTE: External electrical connector terminals are also identified on a label inside the lid. When the lid is removed for connection/adjustment, do not wipe grease from cover shaft seal.

(1) Air Supply.

Connect air supply (pressure between 3.5 and 7 bar, 50 and 100psi.) to the supply port. It is essential that the air is clean, dry and oil-free. Quality class 3.4.4 (according to ISO standard 8573.1) is easily adequate - this implies 5 micron max. particle size, 3 deg. C dew point max., and 5mg/cubic metre max. oil content.

(2) DIN Plug Option.

DIN plug models without the optional limit switches are supplied with only one 4-way DIN plug on the positioner box, and a removeable permanent sealing plug covering the second conduit entry, where another DIN plug can be fitted if it subsequently becomes necessary. If a DIN plug model does have the limit switch option, then a second 4-way DIN plug is fitted; because each limit switch is a 3-terminal device, and there are only two terminals available on the DIN plug for each of the two switches, it is necessary to select normally-open or normally-closed function for each switch by connecting the internal wires from DIN terminals A and B to the appropriate terminal inside the box (see Figure 4 above) - the units are supplied connected for normally-open function.

(3) Positioner Signal.

The positioner signal must be 4-20mA. The positioner gives a positioning response between 0 and 90 degrees linearly proportional to the signal. The positioner is loop powered - that is the signal itself supplies all the electrical power, and no separate power source is needed. In order to supply enough power, the unit requires between approximately 7 and 9 volts to drive the signal current through it - it behaves electrically like a resistor in series with a zener diode. A typical 4-20mA source with a 24v supply is compatible with this input, and can drive a maximum of 2 units in series on one loop.

(4) Angle Retransmit Supply. (Standard 3-Terminal Model).

The optional angle retransmit circuit is also loop powered, requiring 8 to 30 volts to drive the 4-20mA current through it - the current passed is linearly proportional to the actual positioner shaft angle. The retransmit circuit reads the same angle transducing potentiometer as the positioner circuit - however, the angle retransmit circuit remains functional on loss of positioning signal and/or air supply, and the positioner remains functional as long as the signal is present, even if the angle retransmit circuit is fitted and there is no supply to energise its loop. Note that the standard angle retransmit circuit shares its negative terminal with the positioner signal input.

3. SCHEMATIC FUNCTIONAL DIAGRAM (3 terminal models).

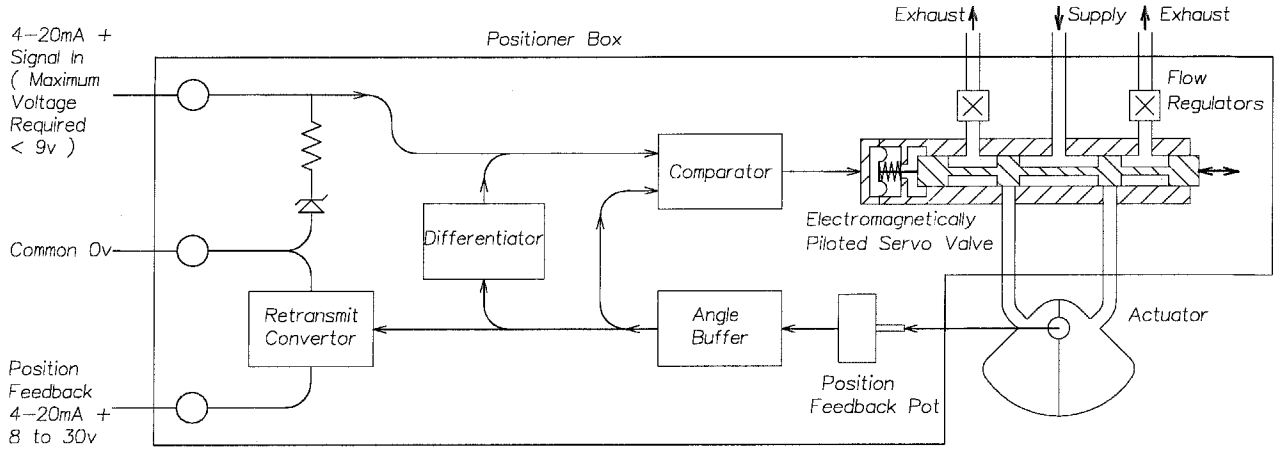


FIGURE 5. SCHEMATIC FUNCTIONAL DIAGRAM OF EL POSITIONER

4. SET UP (3 terminal models).

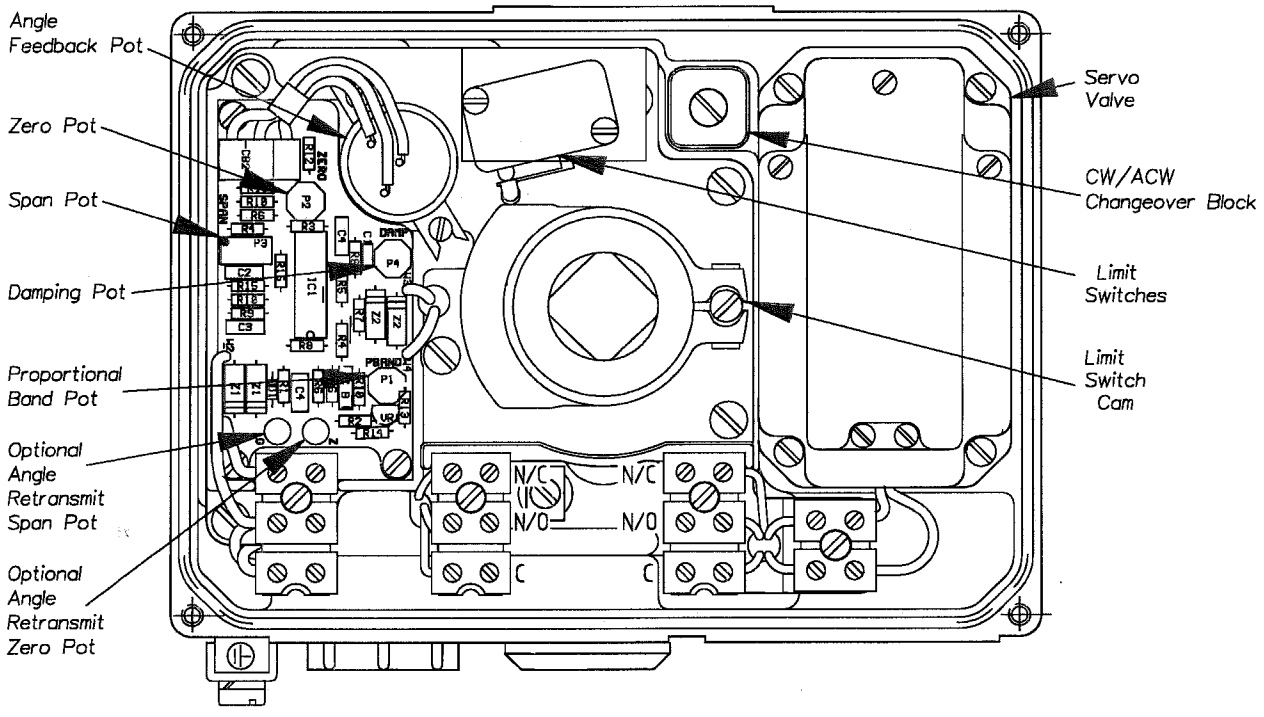


FIGURE 6. CONTROL ADJUSTMENTS, OPEN BOX, TOP VIEW.

When the positioner/actuator combination is installed in its application, set up the control adjustments if necessary. For most applications, it is likely that the factory settings will be satisfactory - the span and zero pots are set to give 0-90 degree movement in response to a 4-20mA signal, the flow regulators are set for maximum travel speed, and the proportional band and damping pots set for a good level of sensitivity and smoothness suitable for most applications. If you need to change the settings, do so in the order given below.

4. SETUP (3 terminal Models) (continued)

(1) Setting Travel Speed.
Set the travel speed using the exhaust flow adjuster screws (see Figure 4.). This only applies if you want to reduce the speed from its supplied maximum factory setting.

(2) Setting Smoothness and Sensitivity.
Adjust the proportional band and damping potentiometers (see Figure 6) to optimize the sensitivity and smoothness of the positioner. With the proportional band pot, you can maximize sensitivity and accuracy, but at the cost of increased jerkiness of response when the signal is ramped smoothly, or you can maximize smoothness at the cost of losing rapidity of response to small changes in signal. When you are happy with the proportional band setting, adjust the damping pot to just avoid overshoot when the signal is stepped suddenly so that the positioner approaches set point at full speed having travelled 45 degrees or more. Try this travelling up and down scale.

(3) Setting Span and Zero.
Adjust the span and zero pots to give exactly the travel you require from your 4-20mA signal. Span and zero should should be set last of all because they are affected by adjustments to the proportional band setting. Big adjustments in zero setting are best carried out by centring the fine zero pot (blue preset on the PCB - see Figure 6), and rotating the the main angle feedback pot having relaxed its clamp screws - avoid undoing the screws too much so that you maintain engagement with the nuts on the other end, and remember to retighten them when you have finished setting the pot position. Adjust the zero setting first, with the signal at 4mA, then the span setting with the signal at 20mA - it may be necessary to repeat this 2 or 3 times to get both set right. The positioner needs a minimum of 3.8mA in order to function correctly (i.e. to supply enough loop power to drive it) - therefore do not aim to position with a signal below 3.8 mA.

(4) Setting Optional Angle Retransmit Span and Zero.
If you have an angle retransmit circuit fitted, it will have been factory set to give 4-20mA output in response to the 0-90 degree position of the actuator. However, if you have adjusted any of the positioner circuit settings, it will be necessary to reset the span and zero pots on the angle retransmit circuit. Set the zero pot to give 4 mA output when the actuator is at 0 degrees, then set the span pot to give 20 mA output when the actuator is at 90 degrees (or other desired maximum setting). If you set the output to read below about 3.5mA at the minimum angle, then there will not be enough power when the positioner loses input signal for the angle retransmit circuit to read correctly independently of the signal.

(5) Setting Optional Limit Switch Cams.
Optional limit switch cams are factory set to give end-of-travel switching with one switch each end. The switching can be set to occur anywhere in the travel angle for each switch, by relaxing the cam clamp screw and rotating the cam to position. Set the lower cam first. Take care to avoid the clamp section of a cam striking a switch at any point in the actuator's travel.

5.CONVERTING CLOCKWISE / ANTI-CLOCKWISE SENSE OF POSITIONER (3 terminal models)

Positioners can be converted from clockwise to anti-clockwise movement on rising signal or visa-versa as follows:-

(1) Disconnect air supply and signal.
(2) Undo screw holding down changeover block (see Figure 6).
(3) Rotate changeover block 90 degrees, taking care to keep rubber gasket lined up with holes in body.
(4) Re-tighten screw holding down changeover block.
(5) Undo outer two angle pot wire terminal screws, and swap blue and yellow wires over to reverse sense of pot connection; re-tighten screws.
(6) Re-connect air supply and signal, and re-zero positioner by unclamping angle pot and rotating pot to give correct travel for 4-20mA signal. Avoid undoing clamp screws too much so that you maintain engagement with the nuts on the other end. Re-tighten screws when pot is positioned correctly.

6. MAINTAINANCE AND TROUBLESHOOTING

The EL positioner is designed to be maintainance free during a long life, if it is supplied with clean, dry oil-free air, and electrical signals free of nise and high voltage spikes.

When the lid is removed, take care not to wipe all grease from shaft cover seal.

Figures 7 and 8 are circuit diagrams of the positioner and angle retransmit circuits respectively.

Table 1 is a troubleshooting guide, which aims to assist only with simple easily remedied problems. If problems persist, contact Kinetrol or a Kinetrol distributor for further assistance.

TABLE 1. Troubleshooting Guide.

Failure to move when signal and air are connected: - Check air pressure - must be above 50psi./3.5 Bar. - Check signal is connected with correct polarity. - Check signal is really above 4 mA - Discrete units - is shaft connected in correct orientation ? - Has main feedback pot been rotated, or does it need rotating because unit has been swapped from/to clockwise/anti-clockwise on rising signal ? - Is air supply clean, dry, and oil free ?
Unit moves slower than expected upscale or downscale:- - Check air pressure - above 50psi /3.5 Bar ? - Check flow adjuster screws - has one been screwed in ? - Is air supply clean, dry and oil free ?
Movements are too jerky:- - Adjust proportional band pot to increase smoothness - then reset damping, span and zero pots as instructed in Section 2.
Lack of sensitivity to changes in signal:- - Adjust proportional band to increase sensitivity - then reset dampin, span and zero pots as instructed in Section 2.
Set point is overshot when positioner moves rapidly:- - Adjust damping pot to eliminate overshoot.

7. ISOLATED ANGLE RETRANSMIT OPTION (4 terminal models).

7.1 Description.

This option gives electrical isolation between the 4-20mA control signal circuit and the angle retransmit circuit. Two separate angle potentiometer tracks (built into a special dual potentiometer) are used to produce inputs to the two circuits. A four-terminal connector block replaces the standard three-terminal common-zero block, and for DIN plug versions the fourth terminal on the signal DIN plug changes its function from ground terminal to angle-retransmit negative - ground connection must then be made via the external screw terminal.

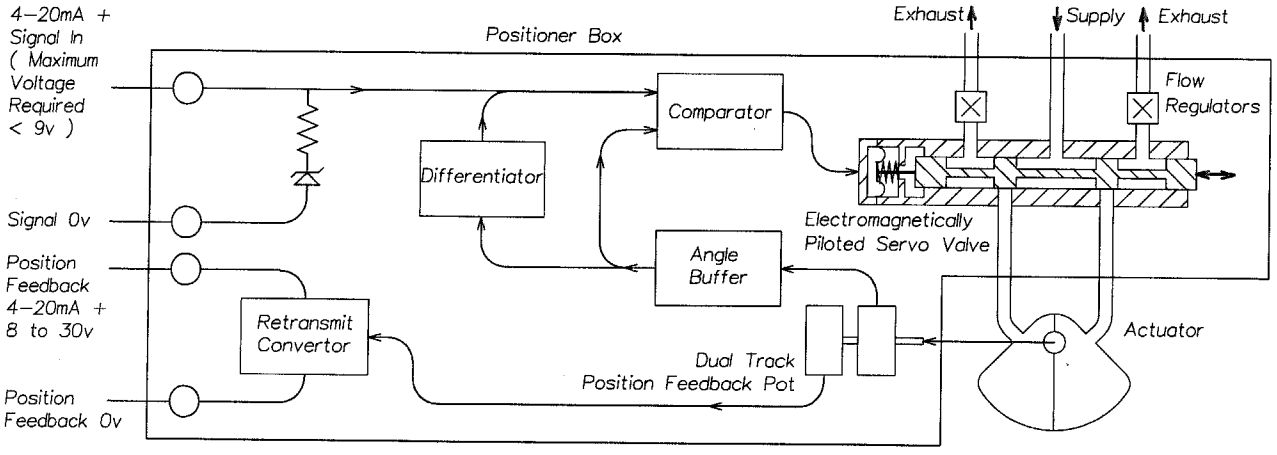


FIGURE 7. SCHEMATIC FUNCTIONAL DIAGRAM OF 4–TERMINAL EL POSITIONER

7.2 Isolated Angle Retransmit Option (4 terminal models) - Connections.

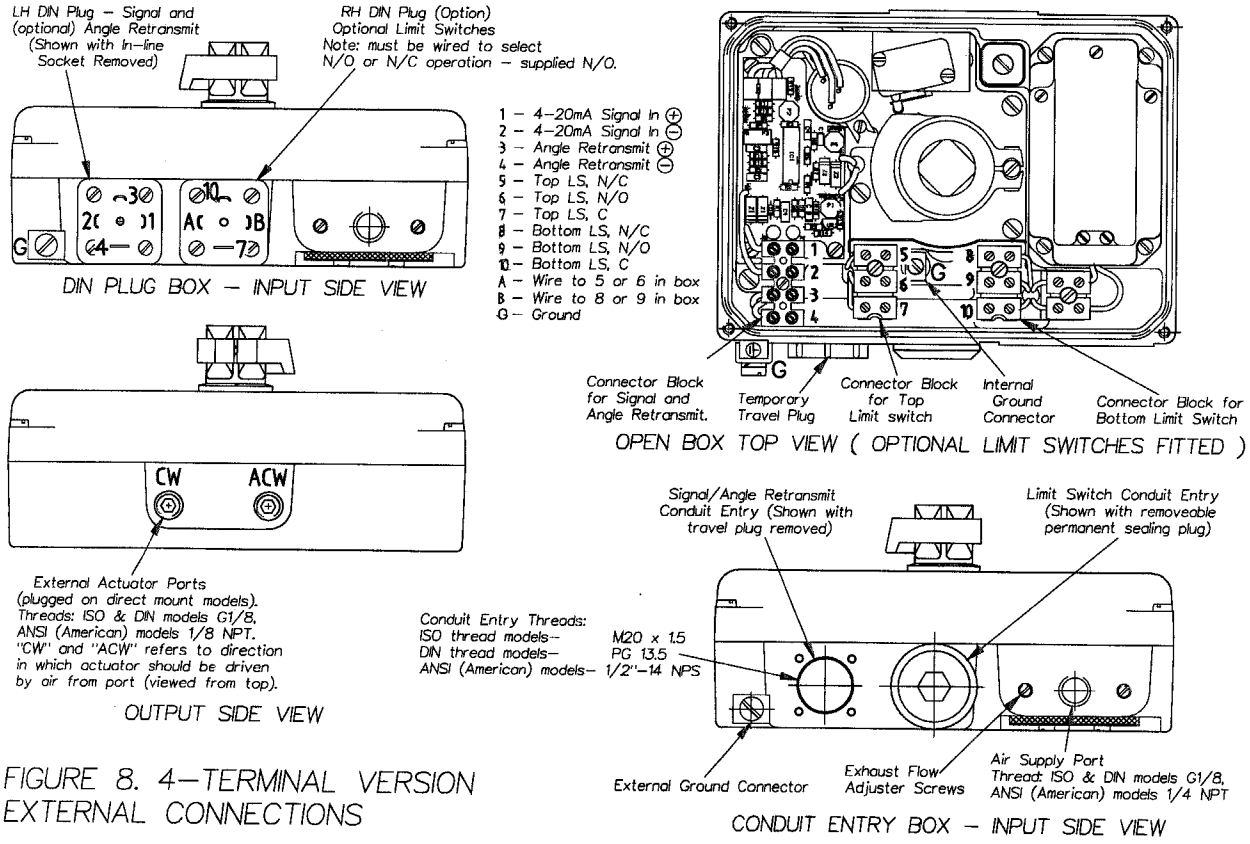


FIGURE 8. 4–TERMINAL VERSION EXTERNAL CONNECTIONS

7. ISOLATED ANGLE RETRANSMIT OPTION (4 terminal models) (Continued).

7.2 Connections (Continued).

(1) Air Supply, DIN Plug Limit Switch, and Positioner Signal.

These are as detailed in section 1.3 - ie. the same as for standard 3-terminal units.

(2) Isolated Angle Retransmit Supply.

The isolated angle retransmit circuit is loop powered, requiring 8 to 30 volts DC to drive the 4-20mA current through it - the current passed is linearly proportional to the actual positioner shaft angle.

7.3 Isolated Angle Retransmit Option (4 terminal models) - Set Up.

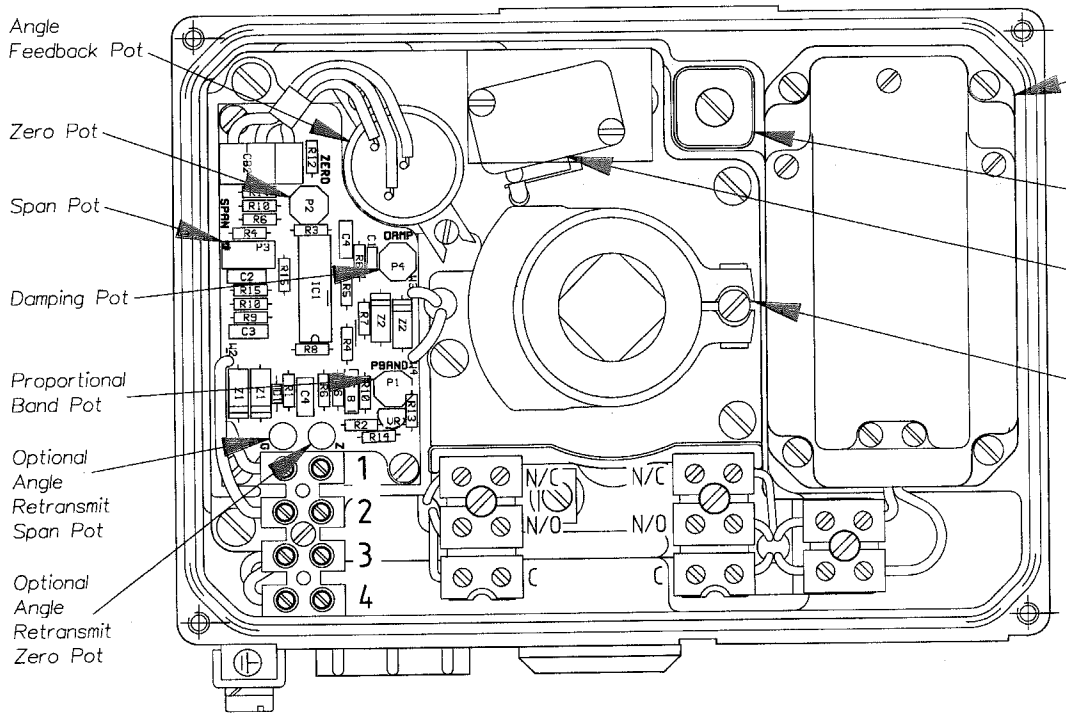


FIGURE 9 4-TERMINAL VERSION, CONTROL ADJUSTMENTS. OPEN BOX, TOP VIEW

The circuit is factory calibrated to give 4-20mA output in response to 0-90 degree position of the actuator. Zero and span can be adjusted to modify the response as required; set the low end of the span (usually 4mA) at the low angle end of travel (usually 0 degrees) by adjusting the angle retransmit zero pot, and then set the high end of the span (usually 20mA) at the high angle end of travel (usually 90 degrees) by adjusting the angle retransmit span pot.

7.4 Isolated Angle Retransmit Option (4 terminal models) - Clockwise/Anticlockwise Conversion.

(1) Move positioner to near mid position.
(2) Disconnect air supply, signal and angle retransmit supply.
(3) Undo screw holding down changeover block (see Figure 9). Rotate changeover block 90 degrees, taking care to keep rubber gasket lined up with holes in body. Retighten screw holding down changeover block.
(4) Undo outer two screws on the positioner circuit 3-way connector block (connecting to angle pot via black, white and red wires), swap over black and red wires to reverse sense of pot connection, and retighten screws.
(5) Disconnect servo valve wires from 2-way terminal on red carrier plate.
(6) Undo 5 large slot-head screws holding red carrier plate down to positioner case. Remove screws and keep.
(7) Lift out carrier plate complete with shaft, circuits and limit switches if fitted - it will be necessary to apply moderate force to the shaft in order to pull it off the actuator square and to overcome O-ring friction.For 07 size and upwards, there is an anti-backlash spring in the shaft interface which should be found and kept.
(8) Underneath the carrier plate, the small rectangular isolated angle retransmit circuit is attached to two metal columns by two screws - remove the screws and keep them. Flip over the circuit, and undo the outer two screws on the 3-way terminal block. Swap over the green and purple wires to reverse the sense of the second pot connection, and retighten terminal screws. Refix the circuit to columns using screws removed earlier.
(9) Follow instructions in section 2.1 starting at (4) describing how to refit carrier plate assembly.

KINETROL

ROTARY 1/4 TURN ACTUATOR/ADD-ON UNITS

Installation, Operation and Maintenance

ACTUATORS

INSTALLATION

1. **Mounting hole sizes — Standard actuator**

Model	*Number of holes*	*ISO thread*	*Depth of thread*	*ANSI thread*	*Depth of thread*
OMO	4	M3 × 0.5	5mm	—	—
01-A	4	M4 × 0.7	6mm	8-36 UNF	15/64"
02	4	M4 × 0.7	8mm	8-36 UNF	5/16"
03	4	M5 × 0.8	10mm	10-32 UNF	3/8"
05	6	M5 × 0.8	10mm	10-32 UNF	3/8"
07	4	M8 × 1.25	16mm	5/16-24 UNF	5/8"
08	6	M8 × 1.25	16mm	5/16-24 UNF	5/8"
09	4	M10 × 1.5	20mm	3/8-24 UNF	25/32"
12	4	M12 × 1.75	24mm	1/2-20 UNF	15/16"
14	4	M16 × 2	28mm	5/8-18 UNF	1 1/8"
16	4	M24 × 3	38mm	7/8-14 UNF	1 1/2"
18	4	M30 × 3.5	50mm	1 1/8-12 UNF	2"

Model 010 has 4 M4 clearance holes.

Mounting hole sizes — DIN actuators

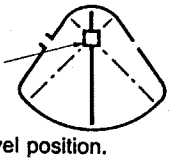
Model suffix 1 is without Namur.
Model suffix 2 is with Namur solenoid valve mounting.

Model	*Number of holes*	*ISO thread*	*Depth of thread*	*PCD*
031 & 032	4	M5 × 0.8	8mm	36mm
051 & 052	4	M5 × 0.8	8mm	42mm
071 & 072	4	M6 × 1	10mm	50mm
091 & 092	4	M8 × 1.25	13mm	70mm
— 102	4	M10 × 1.5	16mm	102mm
121 & 122	4	M10 × 1.5	16mm	102mm
141 & 142	4	M12 × 1.75	20mm	125mm
161 —	4	M20 × 2.5	32mm	165mm

Note: essential that full number of bolts are used and all tightened evenly.

CAUTION: NEVER HAMMER OR USE OTHER UNDUE FORCE ON ACTUATOR DIECAST CASES. DAMAGE TO INTERNAL SEALING FACES WILL RESULT.

2. **Mounting**
   2.1. Actuator and driven unit must be correctly aligned, i.e. actuator vane and driven unit must be able to move in same direction from end stop when coupled together.



Note:
Position of output shaft when vane at mid-travel position.

   2.2. Take particular care in aligning models 05/08. 6-hole mounting means 30° misalignment possible if flange has 60° error and coupling 90° error.
   2.3. There must be no end load on actuator drive shaft. Check clearance between actuator and driven unit drive shaft, allowing for coupling to be used.
   2.4. Care must be taken to ensure concentricity between actuator shaft and driven unit shaft.
   2.5. Actuator can be mounted in any plane.

3. **Drive coupling**
   3.1. Square hole standard drive coupling supplied in mild steel and may be welded or brazed to coupling part to suit drive on driven unit.
   3.2. When mounting tightened down, check there is minimum 1 mm (0.040") end play of coupling on actuator square drive shaft to avoid end load on actuator shaft.

4. **Air supply**
   4.1. Flexible nylon tubing recommended. Size should be relative to supply/exhaust port size on actuator concerned. Undersize tubing or fittings will restrict actuator performance.
   4.2. Air supply to D/A or S/R actuators must be reasonably clean and dry. Lubricated air may be used to D/A or S/R actuators but MUST NOT be used for air supply to Positioners or I/P Converters.

5. **Operation**
   5.1. External stops are strongly recommended when actuator is operating a mechanism with cantilevered load.
   5.2. Second square end of drive shaft may be used for visual position indication, emergency manual operation or driving of add-on units (spring-return unit, limit switch unit, etc.).
   5.3. Operating air pressure should not exceed 7 bar (100 p.s.i.).
   5.4. Operating temperature of actuator should not exceed 80°C (176°F).
   5.5. Visual position indicators are available. Coloured red, made from Nylon 6, they can be fitted over square shaft at top of actuator or top of add-on unit.

6. **Maintenance**
   Maintenance is limited to replacement of seals when wear affects actuator performance. Seal life will vary according to application, conditions of cycle frequency, temperature, condition of air supply, etc. Detailed seal replacement instructions in next section.

7. **Recommended spare parts**
   Standard seal kits, available for each actuator model, consist of the following:
   2 off vane seal
   2 off expander
   2 off shaft seal
   plus all necessary O-rings, studs/screws, nuts and grease for all sizes up to model 08.
   Studs are not included for models 09 and above.
   In addition, a tube of sealant will be required to seal case halves.

8. **Adjustment**
   8.1. Stroke Adjustment — only applies to models with adjustable stops.

Table of standard stroke adjustments available

Models	Adjustment range available each stop
OM/03/07/08/09/16/18	10°
02/05/14	8°
O1A/10/12	11°

Greater adjustment range possible with non standard stop screws. Contact Kinetrol for details.

8.2 Speed Adjustment
Slower operation of actuator is possible, without significant torque output reduction, by external fitment of flow regulator valves.
Faster operation can be achieved under certain conditions by fitting quick exhaust valves.
For full details contact KINETROL.

SEAL REPLACEMENT INSTRUCTIONS

1. **DISMANTLING ACTUATOR (see exploded drawing/parts list)**
   CAUTION: Before dismantling check there are no burrs on square drive shafts. If there are, remove to avoid damage to bearings and shaft seals during removal of case halves. In the case of spring return actuators remove spring unit (according to following section) before opening actuator case.
   1.1. Models with visible spring pins in case flanges: using correct size flat end punch tap these halfway out.
   1.2. All models: remove all case securing screws.

1.3. Separate case halves by connecting air line to inlet port and blowing them apart. Procedure is safe although producing a "bang". Pull off one case half.
CAUTION: Do NOT hammer diecast castings or shaft end. It will damage internal sealing surfaces.
1.4. Clean both case halves removing silicone rubber sealant. Clean joint surfaces of case flange with surgical spirit.
1.5. Replace and lubricate shaft seals.
1.6. Undo nuts and remove old expanders and seals from vane. Take care not to damage side plates. Clean vane.

2. REASSEMBLY VANE

2.1. Check studs are tight through vane and equal length each side. If not, apply Loctite to thread and relocate correctly in vane.
2.2. Model 18: Apply SILASTIC 732 RTV sealant around bottom of studs (to prevent air leakage through seal on vane stud holes.
2.3. Fit new seal over studs after checking profile matches vane profile.
2.4. Fit seal expander — the hole in it shaped like vane outline shows correct way round — teeth pointing away from vane.
2.5. Model 08 only: fit 'O' ring over studs on top of expanders.
2.6. Fit side plate over studs.
2.7. Fit new nuts to studs after applying Loctite medium strength sealant to threads.
2.8. Tighten nuts to following torques:

Model OMO	1¼ lbf. ins.	0.015 m kg	
01/01A	4 lbf. ins.	0.05	m kg
02	6 lbf. ins.	0.07	m kg
03	6 lbf. ins.	0.07	m kg
05	8 lbf. ins.	0.09	m kg
07	8 lbf. ins.	0.09	m kg
08	20 lbf. ins.	0.23	m kg
09	20 lbf. ins.	0.23	m kg
10	20 lbf. ins.	0.23	m kg
12	30 lbf. ins.	0.35	m kg
14	30 lbf. ins.	0.35	m kg
16	100 lbf. ins.	1.2	m kg
18	100 lbf. ins.	1.2	m kg — M6 studs
18	250 lbf. ins.	2.8	m kg — M8 studs

3. REASSEMBLY ACTUATOR

3.1. Coat bearing bushes and inside both case halves with molybdenum disulphide grease.
3.2. Lightly and evenly coat joint face on each case half with SILASTIC 732 RTV sealant obtainable from KINETROL or Dow Corning. (In emergency, Dow Corning bath sealant obtainable from ironmongers, etc., may be used as substitute.)
CAUTION: EXCESS SEALANT, if extruded inside case, WILL DAMAGE SEALS. Remove all excess sealant especially from inside edge.
3.3. Insert vane into one case half, turning it to ease square on drive shaft through shaft seal. Watch that lip seals at ends of vane easily work down into case without damage.
SPECIAL NOTICE: If model concerned has threaded holes around one case half use that half for this operation.
3.4. Fit remaining case half on top of the other turning it to ease square through shaft seal.
3.5. Carefully tap the spring pins back into the other case half before tightening screws.
CAUTION: Check that lip seals are not trapped at case joint face when leather or viton seals are fitted.
3.6. Tighten case screws to the following torques:

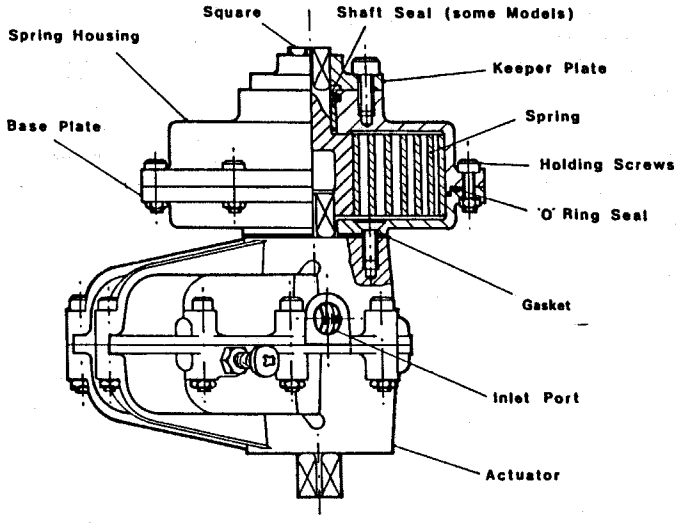
Model OMO	4 lbf. ins.	0.045 m kg
01	10 lbf. ins.	0.12 m kg
01A	10 lbf. ins.	0.12 m kg
02	10 lbf. ins.	0.12 m kg
03	10 lbf. ins.	0.12 m kg
05	20 lbf. ins.	0.23 m kg
07	20 lbf. ins.	0.23 m kg
08	70 lbf. ins.	0.8 m kg
09	60 lbf. ins.	0.7 m kg
10	60 lbf. ins.	0.7 m kg
12	100 lbf. ins.	1.2 m kg
14	120 lbf. ins.	1.4 m kg
16	860 lbf. ins.	10 m kg
18	1050 lbf. ins.	12 m kg

3.7. Rotate vane manually to check movement and wipe away sealant extruded internally.
3.8. Allow setting time for sealant before applying test air pressure.

SPRING RETURN UNITS

1. REMOVAL OF SPRING RETURN UNIT

WARNING — the wound-up steel springs are storing a large amount of energy which, if suddenly released, can be dangerous.



1.1. A keeper plate strong enough to take full spring torque *must* be fitted in order to remove S/R unit without releasing spring tension. See also alternative method for S/R units with worm drive spring adjustment. *Note:* Keeper plates and screws available from Kinetrol.
1.2. Connect air line via pressure regulating valve to actuator air inlet.
1.3. Place Keeper plate over square shaft protruding from S/R unit.
1.4. Increase air pressure slowly until actuator vane turns to mid-travel position. (See sketch at 2 of ACTUATOR section.) Keeper plate holes will then line up with threaded holes in Spring Housing.
1.5. Insert all screws through keeper plate holes and tighten to lock keeper plate in position. Disconnect air supply.
1.6. Separate Spring Housing from base plate by removing holding screws. Then remove Spring Housing.
1.7. If necessary to gain access to actuator screws also remove Base Plate by removing screws. Take care with gasket between Base Plate and actuator. (Service Actuator as required per Seal Replacement Instructions.)

2. REASSEMBLY OF SPRING RETURN UNIT

2.1. If necessary replace Base Plate after replacing gasket.
2.2. Ensure actuator vane is in mid-travel position.
2.3. Locate Spring Housing on shaft, rotate it to line up holding screw holes with baseplate and replace holding screws.
2.4. Connect air supply (as in 1.2.) to actuator inlet port.
2.5. Adjust air pressure until it balances the spring tension.
2.6. Loosen keeper plate screws. If air pressure correctly balancing spring tension screws will not bind. If binding adjust air pressure until balanced.
2.7. Remove keeper plate completely.
2.8. Disconnect air supply.

3. **ALTERNATIVE REMOVAL/REASSEMBLY WORM DRIVE SPRING RETURN UNITS**

Worm drive Spring Return Units may be removed/reassembled as under 1 and 2 above. An alternative method without use of keeper plate is —

3.1. Note position of S/R unit relative to actuator.
3.2. Undo worm locking screws but do not remove them.
3.3. Turn worm anti clockwise until spring tension is released counting number of complete and part turns of S/R unit relative to actuator. Note number of complete and part turns.
3.4. Separate Spring Housing from Base Plate and Worm Drive by removing holding screws.
3.5. Remove Spring Housing and service actuator as required.

REASSEMBLY

3.6. Locate Spring Housing on shaft.
3.7. Ensure worm is correctly located in housing. End of worm with socket wrench location must be facing the opposite direction to the arrow head shown on the adhesive label fixed to the housing.
3.8. Offer up worm housing and ring locating worm teeth in rack and lining up holding screw holes.
3.9. Replace and tighten holding screws.
3.10. Turn worm clockwise until reaching same number of complete and part turns of S/R unit as noted during removal.
3.11. Do up worm locking screws.

ADJUSTMENT SPRING TENSION

WARNING: The wound-up steel springs are storing a large amount of energy which, if suddenly released, can be dangerous.

SPECIAL NOTE: User adjustment of types without worm drive should only be attempted if correct equipment and facilities are available.

4.1. *Tension Setting Definitions*

4.1.1. Optimum setting is when S/R unit is able to provide as much output torque on the spring return stroke as that produced by the corresponding air stroke at a particular air supply pressure.

4.1.2. Differential setting is when S/R unit produces more or less output torque on spring return stroke as that produced by the corresponding air stroke at a particular air supply pressure.

4.1.3. Operating air pressure in these instructions means the actual air supply pressure at which the actuator will be operated.

4.2. *Optimum Spring Setting Test*

4.2.1. Detach actuator/spring return from valve or mechanism operated by them.

4.2.2. Attach air supply to actuator through pressure regulating valve and gauge with supply shut off at regulator.

4.2.3. Gradually open regulator to increase air supply to actuator until actuator output shaft just begins to move.

4.2.4. Note actual pressure at which actuator output shaft moved.

4.2.5. If actual pressure noted at 4.2.4. is about half the operating air pressure then spring tension is at optimum.

If actual pressure noted at 4.2.4. is significantly less than half operating air pressure then spring tension is below optimum, i.e. output torque on S/R stroke will be less than that produced on corresponding air stroke at operating air pressure.

Conversely if actual pressure at 4.2.4. is significantly greater than half operating pressure then spring tension is above the optimum, i.e. S/R torque will be greater than air stroke torque.

4.3. *Tension Adjustment Method (Standard S/R units without worm drive)*

4.3.1. Equipment/facilities required:
Air supply with pressure regulator valve and gauge in line.
Keeper plate with bolts and spacers (KINETROL supply).
Spanners/tools to suit.

4.3.2. Detach actuator/spring return from valve/mechanism.

4.3.3. Connect air supply to actuator with regulator shut off.

4.3.4. Carry out Optimum Spring Setting Test as at 2.2. above to determine whether spring tension needs to be increased or decreased.

4.3.5. Gradually open air supply regulator until actuator vane is at centre of travel (45°) position (see sketch at page 1).

4.3.6. Place keeper plate over S/R square shaft at top of S/R unit.

CAUTION: If keeper plate of flat type spacer washers at least 3 mm (1/8") thick must be used under keeper plate. KINETROL die cast keeper plates do not need spacer washers.

4.3.7. If bolt holes of keeper plate do not line up with corresponding tapped holes in S/R unit carefully open or close air supply regulator until S/R square shaft turns so that holes do line up.

4.3.8. Insert and tighten keeper plate bolts.

4.3.9. Shut off air supply to actuator.

4.3.10. Undo and remove all spring housing flange bolts. Leave spring housing resting on base plate.

4.3.11. Turn spring housing in required direction according to:
a) S/R operating direction, i.e. clockwise or anticlockwise operation of spring force, and
b) Tension required to be increased or decreased.

NOTE: Larger sizes of actuator/spring return will require spanner and possibly extension bar to turn spring housing through square shaft on S/R unit.

4.3.12. Dependent on the age of S/R unit concerned there will be 12 or 24 bolt holes around the base plate flange (except for 010 model which has only 4 and 140 model which now has 36).

Therefore older models (12 holes) can only be adjusted by 30° steps whereas newer models can be adjusted by 15° steps (010 by 90° steps and current 140 by 10° steps.)

4.3.13. As a rough guide 30° adjustment of spring housing relative to base plate will give 8% change of spring torque output providing spring is already tensioned within its operating air pressure range, i.e. standard S/R units between 50 and 80 p.s.i. Low air supply S/R units between 25 and 50 p.s.i. See catalogue for full details.

4.3.14. Maximum adjustment in one step will be 45° controlled by available vane movement in actuator.

4.3.15. After turning spring housing by amount required (or possible) line up bolt holes in spring housing and base plate flanges. Insert flange bolts and tighten nuts.

4.3.16. Carefully open air supply to actuator until side load on keeper plate bolts is relieved.

4.3.17. Remove keeper plate.

4.3.18. Repeat Optimum Spring Setting Test as at 4.2. above.

4.3.19. If necessary repeat operations 4.3.5. to 4.3.17. to further increase or decrease spring tension.

WARNING: Spring tension must *not* be further increased if air pressure noted at 4.2.4. is 40 p.s.i. or more for standard S/R units or 30 p.s.i. for special low air supply types.

4.4 *Method (Worm Drive Type S/R Units)*

4.4.1. Carry out Optimum Spring Setting Test as at 4.2 above.

4.4.2. Loosen locking screws on worm.

4.4.3. To reduce spring tension turn worm anticlockwise.
To increase spring tension turn worm clockwise.

As a rough guide 30° adjustment of spring housing relative to base plate will give approximately 8% change of spring torque output providing spring is already tensioned within its operating air pressure range. See 4.3.13. above.

4.4.5. After adjustment carry out Optimum Spring Setting Test as at 4.2 above.

4.4.6. When optimum setting achieved retighten locking screw on worm.

WARNING: Spring tension must *not* be further increased if air pressure noted at 4.2.4. is 40 p.s.i. or more.

PNEUMATICALLY CONTROLLED POSITIONING ACTUATORS

1. **INTRODUCTION**

1.1 THE POSITIONER/ACTUATOR UNIT

The standard unit consists of a Kinetrol quarter-turn pneumatic rotary actuator which has been suitably modified and fitted with a specially designed and precision manufactured pneumatically controlled positioner.

1.2 SITE ADJUSTMENTS

N.B. — The Actuator/Positioner Unit is factory set and "on site"

adjustments should be confined to zero setting and, if necessary, range adjustment.

1.3 RE-SETTING

Full setting requirements and instructions have been included in case the factory setting has been accidentally disturbed and it is not found practical to return the unit to the supplier.

2. CHARACTERISTICS OF THE POSITIONER/ACTUATOR UNIT

2.1 THE STANDARD POSITIONER

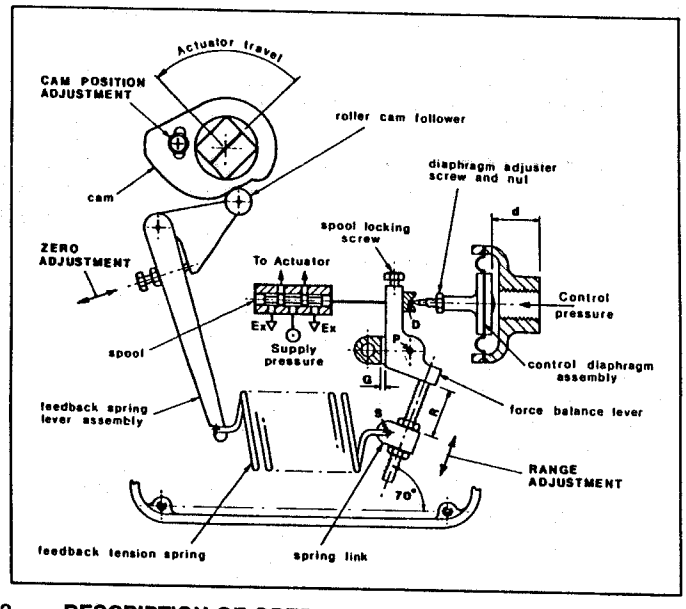
This unit is factory set to position itself within a centrally disposed angular range of 90° in direct and linear response to 3-15 psig control pressure. The standard unit may be requested to have either a clockwise or an anticlockwise response to control pressure. The provision of zero set and range adjustment enables the factory set linear characteristics to be altered on site to within the following limits.

Control Pressure of 3 psig at 0°
is settable between 13.5 and 18.5 psig at 90°
OR Control Pressure of 0.2 bar at 0°
is settable between 0.91 and 1.26 bar at 90°

2.2 NON-STANDARD AND SPECIAL PURPOSE POSITIONERS

The Positioner/Actuator may be characterised to most special requirements of linear or non-linear angular response to standard or non-standard control pressures. This is made possible by being able to characterise the feedback cam and/or by the selection of a suitable feedback spring.

An example of a characterised positioner is found in a unit which is required to open a valve so that the percentage of flow rate through it is proportional to a change in control pressure within predetermined pressure limits.



3. DESCRIPTION OF OPERATION (see diagram)

The Positioner/Actuator unit uses the force balance principle of operation. Essentially, a force which is proportional to the control pressure (obtained through a diaphragm arrangement) loads one side (at point D) of the force balance lever (D.P.S.). This is opposed (at point S) by a feedback force which is related to the angular position of the actuator shaft. The shaft position feedback force is obtained from a feedback spring which is caused to deflect by a spring lever/cam follower assembly acting against a suitably profiled cam which is connected to the actuator shaft.

An out of balance force condition causes the force balance lever to tilt about pivot point P. The spool of a servo valve is linked to the force balance lever assembly and an out of balance condition causes the servo valve to create a differential air pressure across the actuator vane and forces it to rotate in the direction which would cause balance.

The servo valve reduces and removes the effective differential air pressure across the actuator vane as the condition of force balance is approached and reached. In this manner the Positioner/Actuator Unit will always move to the position demanded by the control pressure.

4. ON-SITE FITTING AND SETTING INSTRUCTIONS

4.1 FITTING OF ACTUATOR/POSITIONER UNIT

The Actuator/Positioner Unit is fitted to the unit it is intended to drive or operate in the same way as an actuator without a positioner — i.e. through suitable mounting bracket and shaft couplings. However, if a Spring Return Unit is also attached it will be necessary for the whole unit to be mounted so that the S/R Unit lies between the mounting bracket and the actuator.

4.2 ON-SITE ADJUSTMENTS TO FACTORY SETTINGS

Zero set and, if necessary, range adjustment are the only recommended adjustments needed to align the travel of the positioner so that it coincides with the required travel of the driven unit. The following setting up procedure should be followed:

(a) Check that the Actuator/Positioner Unit is firmly bolted (through a recommended bracket assembly) to the unit it is intended to operate.
(b) Remove the cover of the positioner.
(c) Connect power air to the positioner unit so that it also passes through the recommended filter unit.
(d) Connect the control pressure air line to the appropriate port in the diaphragm housing of the positioner unit.
(e) Gradually apply control pressure and make sure that the Positioner/Actuator unit responds to the control pressure.
(f) Increase the control pressure to maximum (usually 15 psig) and check that the actuator is able to operate through its intended travel.
(g) Reduce control pressure to read exactly 3 psig (or the desired minimum control pressure) and note shaft position.
(h) If necessary re-set the zero adjuster screw of the positioner ur until the driven unit is at the required starting position of its travel range.
(i) Increase the control pressure to exactly 15 psig (or the desired maximum control pressure) and check if the angular position of the driven unit is at the required maximum travel position. Make sure that it is noted if the driven unit reaches its end stop before the maximum control pressure has been applied.
(j) If the total travel is not as required adjust the range setting to suit. (About ½ degree of range adjustment is caused by turning the range adjuster nuts through one spanner flat.)
(k) Reduce the control pressure back to 3 psig (or minimum required control pressure) and check start position. Adjust zero setting if necessary.
(l) Operate the actuator between minimum and maximum control pressure and check end of travel positions. Adjust until the limits are as required and repeatable.
(m) Switch off air supplies and disconnect supply to the positioner unit.
(n) Make sure that all adjuster screws and nuts are locked in their set positions.
(o) Replace positioner cover.

5. RE-SETTING OF POSITIONER UNIT

5.1 INTRODUCTION

(a) All Positioner/Actuator Units are factory set and tested.
(b) These instructions are to give guidance to customers who, for some reason, wish to reset the unit themselves or do not find it practical to return the unit to the factory.
(c) Kinetrol Ltd. cannot take any responsibility for any damage or malfunction caused by mis-handling.

5.2 THE OBJECTIVES OF SETTING UP (see diagram)

The correct force balance relationship must be obtained between the forces exerted by the control pressure and feedback system. Moreover the condition of balance between forces has to be precisely sensed by the servo valve. This essentially determines that the three functional assemblies (Control Diaphragm, Servo Valve and Feedback assemblies) are connected to the force balance assembly so that a condition of balance occurs at the mid-travel position of the force lever assembly.

In the *balanced condition* the correct relative positions of the assemblies should be as follows:

(a) *Force Balance Lever Assembly*

This pivots at point P. Gap G allows limited angular travel. The balanced position of the lever assembly should be coincident with the mid position of angular travel.

(b) *Control Diaphragm Assembly*

The control diaphragm assembly has a displacement stroke of about 2mm and pivots on the force balance lever assembly. The diaphragm should be in the mid stroke position when the balance lever assembly is in the balanced position.

(c) The spool of a servo valve is connected to the force balance lever assembly through a flexible but substantially stiff wire. The spool's position in the servo valve must be exactly central when the lever assembly is in the balanced position.

(d) *Feedback System*
The feedback system consists of a characterised cam (connected to the output shaft), a cam follower/spring lever assembly which is pivoted and connected to the force balance lever through the feedback spring. (i) The cam must be locked in a position so that the cam follower has just started engagement on the cam profile when the actuator is at the beginning of its stroke. (ii) The zero set screw is adjusted so that the feedback spring provides just enough load to cause force balance equilibrium with a 3 psig control pressure at zero degrees of travel. (iii) The range is set so that the feedback spring provides a balancing force with a 15 psi control pressure at 90°.

5.3 PROCEDURE FOR SETTING UP POSITIONER
The assumption is made that the Positioner/Actuator Unit is fully assembled, not connected to an external load and free of leaks.

5.3.1 PREPARATION AND FRICTION CHECK

(a) Disconnect both air supplies to the unit.

(b) Check the filter which is housed in the main air supply port. Replace or clean it if dirty.

(c) Remove the feedback spring.

(d) Disconnect the spool of the servo valve from the force balance lever assembly.

(e) Check the spool and balance lever assembly for friction. Any obvious frictional resistance to movement in these components must be cured at this stage. (Spool friction might be eliminated by removing spool and carefully cleaning spool and valve bore with degreasing fluid.)

5.3.2 *Force Balance Lever Assembly*
For the purpose of setting up, the force balance lever assembly has to be held in its mid-travel position. This may be achieved by sliding shims into the Gap G, until the lever assembly is trapped in its mid-position.

5.3.3 *Diaphragm Setting*

(a) If the positioner has been factory set and the diaphragm adjuster screw and nut have not been moved, it should not be necessary to re-set the diaphragm assembly.

(b) With the force balance lever assembly shimmed in mid-position, the central diaphragm assembly should be able to move through half of its working stroke — i.e. 1mm. Also dimension 'd' should be 17mm.

(c) If the diaphragm assembly requires re-setting the diaphragm adjuster screw should be re-positioned so that the above mentioned conditions are achieved.

(d) Make sure that the lock nut of the adjuster screw is re-tightened before making a dimensional check.

5.3.4. *Servo-Valve Spool Connection*

(a) With the spool locking screw undone, make sure that the spool is free to move within the valve.

(b) Position the spool centrally in the valve.

(c) Connect and switch on the power air supply to the valve.

(d) Manually move the spool and position it until the Positioner/Actuator Unit remains stationary somewhere between 30 degrees and 60 degrees of travel.

(e) Tighten spool locking screw and make sure that the actuator is still stationary and in a state of pneumatic balance between end stops.

(f) REMOVE FORCE BALANCE LEVER LOCKING SHIMS.

(g) Move spool to bring Actuator back to its start position.

(h) Switch off the mains air supply.

5.3.5 *Friction Check*

(a) A force of no more than 25gm applied in either direction to the force balance lever along the line of action of the control diaphragm assembly should cause spool movement.

5.3.6 *Feedback System*

(a) Make sure that the Actuator/Positioner Unit is on the end of its start position.

(b) Replace the feedback tension spring.

(c) Slacken the cam locking screw and rotate the cam manually until the cam following roller is engaged with the rise region of the cam at a position just off the base diameter of the cam.

(d) Tighten the cam locking screw.

5.3.7. *Zero and Range Adjustments*

(a) Set range adjustment so that dimension 'R' is about 7.5mm.

(b) Connect the control pressure line to the diaphragm chamber and set the control pressure to exactly 3 psig (or minimum control pressure).

(c) Switch on the supply air to the servo valve.

(d) Adjust the zero adjuster screw until the actuator is in its required start position.

(e) Set the control pressure to exactly 15 psig (or maximum control pressure).

(f) Adjust range until the actuator is in pneumatic balance at the required end of travel position.

(g) Reduce control pressure back to 3 psig and check start position. Adjust zero setting again if necessary.

(h) Operate the actuator between minimum and maximum control pressure and check end of travel positions. Adjust range and zero settings until the actuator travel limit positions are as required and repeatable.

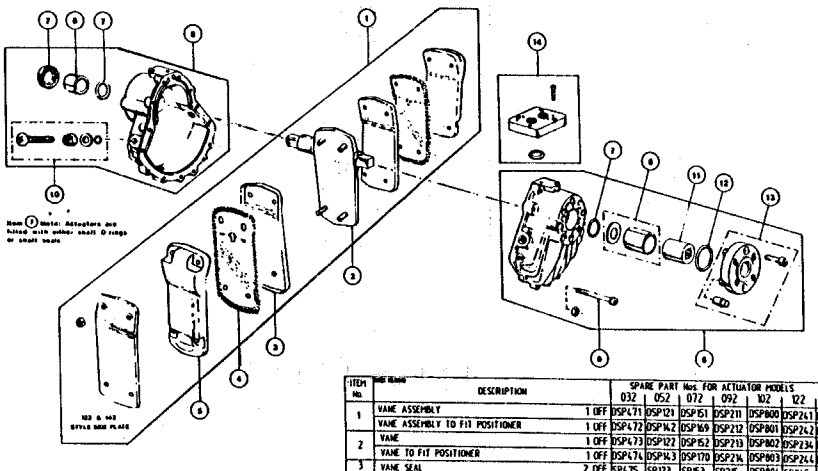
(i) Make sure that all adjuster screws and nuts are locked in their set positions.

6. SPEED ADJUSTMENT

Two flow regulators may be fitted in the exhaust manifold to facilitate speed adjustment.

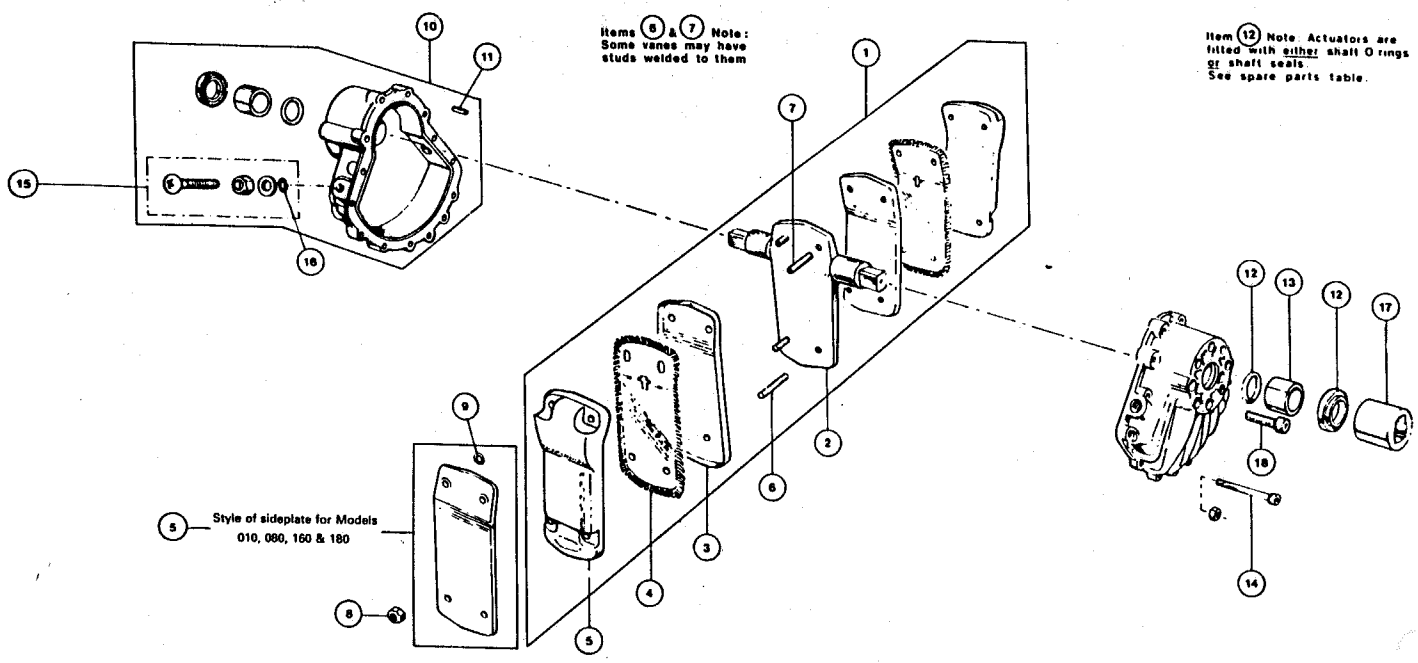
(a) Turn flow regulation needle valves clockwise to reduce speed and anti-clockwise to increase speed.

(b) Each needle valve controls the speed of rotation in one direction only.



EXPLODED VIEW OF A TYPICAL ISO/DIN FEMALE DRIVE ACTUATOR

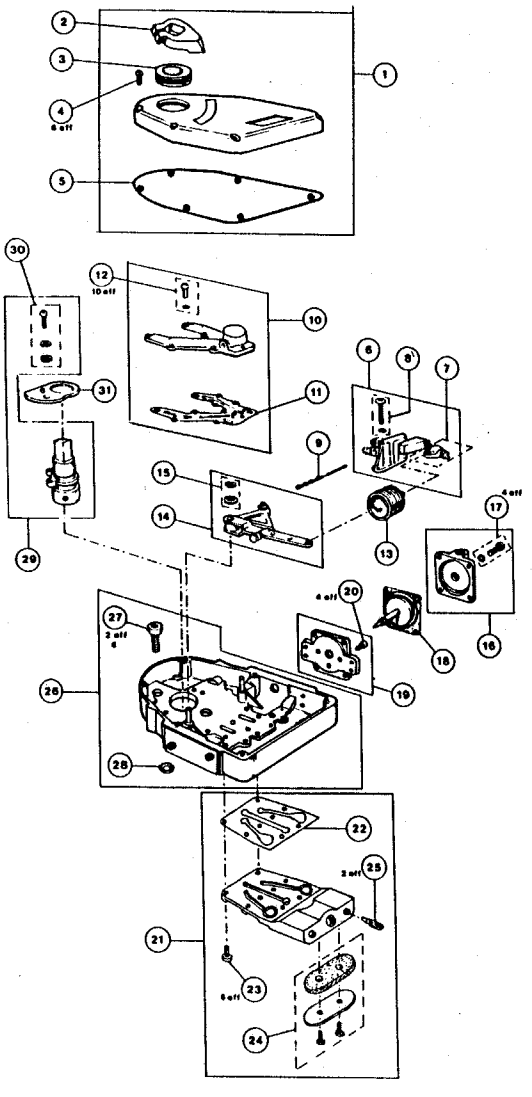
ITEM No.	DESCRIPTION		SPARE PART Nos. FOR ACTUATOR MODELS 032	052	072	092	102	122	142
1	VANE ASSEMBLY	1 OFF	DSP471	DSP121	DSP151	DSP211	DSP800	DSP241	DSP271
	VANE ASSEMBLY TO FIT POSITIONER	1 OFF	DSP472	DSP142	DSP169	DSP212	DSP801	DSP242	DSP272
2	VANE	1 OFF	DSP473	DSP122	DSP152	DSP213	DSP802	DSP234	DSP273
	VANE TO FIT POSITIONER	1 OFF	DSP474	DSP143	DSP170	DSP214	DSP803	DSP244	DSP274
3	VANE SEAL	2 OFF	SP475	SP123	SP153	SP215	DSP804	SP245	SP275
4	EXPANDER	2 OFF	SP476	SP124	SP154	SP216	DSP805	SP246	SP276
5	SIDE PLATE	2 OFF	SP477	SP125	SP155	SP217	DSP806	SP247	SP277
6	CASE	MATCHED PAIR	DSP479	DSP129	DSP159	DSP221	DSP811	DSP253	DSP283
	CASE TO FIT POSITIONER	MATCHED PAIR	DSP480	DSP130	DSP160	DSP222	DSP812	DSP254	DSP284
7	SHAFT SEAL	2 OFF	SP482	SP133	SP162	SP224	DSP814	SP256	SP286
8	BEARINGS & WASHER	SET	DSP483	DSP135	DSP163	DSP225	——	DSP258	DSP288
9	CASE SCREW & NUT	SET	SP484	SP136	SP164	SP226	DSP816	SP259	SP290
10	ADJUSTABLE STOP	2 OFF	SP485	SP138	SP165	SP227	DSP817	SP260	SP292
11	COUPLING	1 OFF	DSP487	DSP140	DSP167	DSP229	——	DSP264	DSP298
12	'O' RING	1 OFF	DSP490	DSP147	DSP172	——	——	DSP268	DSP302
13	DIN FLANGE	1 OFF	DSP491	DSP148	DSP173	DSP232	——	DSP269	DSP303
14	NAMUR ADAPTOR KIT	1 OFF	SP633						



EXPLODED VIEW OF A TYPICAL STANDARD ACTUATOR

ITEM No.	DESCRIPTION		SPARE PART Nos FOR ACTUATOR MODELS													
			0M0	010	010A	020	030	050	070	080	090	101	120	140	160	180
1	VANE ASSEMBLY	1 OFF	SP 061	SP 061	SP 331	SP 091	SP 471	SP 121	SP 151	SP 181	SP 211	DSP 808	SP 241	SP 271	SP 371	SP 311
	VANE ASSEMBLY TO FIT POSITIONER	1 OFF	—	—	—	—	SP 472	SP 142	SP 169	SP 202	SP 212	DSP 801	SP 242	SP 272	—	—
2	VANE	1 OFF	SP 062	SP 062	SP 332	SP 092	SP 473	SP 122	SP 152	SP 182	SP 213	DSP 802	SP 243	SP 273	SP 372	SP 312
	VANE TO FIT POSITIONER	1 OFF	—	—	—	—	SP 474	SP 143	SP 170	SP 203	SP 214	DSP 803	SP 244	SP 274	—	—
3	VANE SEAL	2 OFF	—	SP 063	SP 333	SP 093	SP 475	SP 123	SP 153	SP 183	SP 215	DSP 804	SP 245	SP 275	SP 373	SP 313
4	EXPANDER	2 OFF	—	SP 064	SP 334	SP 094	SP 476	SP 124	SP 154	SP 184	SP 216	DSP 805	SP 246	SP 276	SP 374	SP 314
5	SIDE PLATE	2 OFF	—	SP 065	SP 335	SP 095	SP 477	SP 125	SP 155	SP 185	SP 217	DSP 806	SP 247	SP 277	SP 375	SP 315
6	SHORT STUD	SET	—	—	—	—	—	—	SP 156	SP 186	SP 218	DSP 807	SP 248	SP 278	SP 376	SP 316
7	LONG STUD	SET	—	SP 067	SP 336	—	—	—	SP 157	SP 187	SP 219	DSP 808	SP 250	SP 280	SP 377	SP 317
8	NUT	SET	—	SP 068	SP 337	SP 098	SP 478	SP 144	SP 158	SP 188	SP 220	DSP 809	SP 251	SP 281	SP 378	SP 318
9	'O' RING	SET	—	—	—	—	—	—	—	SP 189	—	—	SP 252	SP 282	—	—
10	CASE	MATCHED PAIR	SP 063	SP 069	SP 338	SP 099	SP 479	SP 126	SP 159	SP 190	SP 221	DSP 811	SP 253	SP 283	SP 379	SP 319
	CASE TO FIT POSITIONER	MATCHED PAIR	—	—	—	—	SP 480	SP 130	SP 160	SP 191	SP 222	DSP 812	SP 254	SP 284	—	—
11	PIN (SPRING)	SET	—	—	SP 339	SP 100	SP 481	SP 131	SP 161	SP 206	SP 223	—	SP 255	SP 300	SP 380	SP 320
	PIN (DOWEL)	SET	—	SP 070	—	—	—	SP 132	—	SP 192	—	DSP 813	SP 256	SP 285	—	—
12	SHAFT SEAL (NOT 010, 030 OR 080)	2 OFF	—	—	—	SP 101	—	SP 133	SP 162	—	SP 224	—	SP 258	SP 286	SP 381	SP 321
	SHAFT O RING (010, 030 & 080 ONLY)	2 OFF	—	SP 071	SP 340	—	SP 482	—	—	SP 193	—	DSP 814	—	—	—	—
	SHAFT O RING (EARLIER MODELS 050, 120 & 140)	2 OFF	—	—	—	—	—	SP 134	—	—	—	—	SP 257	SP 287	—	—
13	BEARING	2 OFF	—	SP 072	SP 341	SP 102	SP 483	SP 135	SP 163	SP 194	SP 225	DSP 815	SP 259	SP 288	SP 382	SP 322
	BEARING (140 WITH O RING SHAFT SEAL)	2 OFF	—	—	—	—	—	—	—	—	—	—	—	SP 289	—	—
14	CASE SCREW AND NUT	SET	—	SP 342	SP 342	SP 103	SP 484	SP 136	SP 164	SP 207	SP 226	DSP 816	SP 259	SP 290	SP 383	SP 323
	CASE SCREW (ONLY 010, 050, 090 AND EARLIER MODELS 140)	SET	—	SP 073	—	—	—	SP 137	—	SP 195	—	—	—	SP 291	—	—
15	ADJUSTABLE STOP	2 OFF	—	—	SP 345	SP 104	SP 485	SP 138	SP 165	SP 204	SP 227	DSP 817	SP 260	SP 292	SP 384	SP 324
16	O RING (STOP)	2 OFF	—	—	SP 346	SP 105	SP 486	SP 139	SP 166	SP 205	SP 228	DSP 818	SP 261	SP 293	SP 385	SP 325
17	COUPLING	1 OFF	—	SP 074	SP 343	SP 106	SP 487	SP 140	SP 167	SP 208	SP 229	—	SP 264	SP 298	SP 386	SP 326
18	BRACKET SCREWS	SET	—	SP 075	SP 344	SP 107	SP 488	SP 141	SP 168	SP 201	SP 230	DSP 819	SP 265	SP 299	SP 387	SP 327
19	INDICATOR ASSEMBLY	1 OFF	—	—	—	SP 108	SP 489	SP 148	SP 171	—	SP 231	DSP 820	SP 267	SP 301	—	—

*For actuators built to ANSI standard (e.g. 059–100) change Spare Part No. prefix from SP to ASP (e.g. for Actuator 059–100 Item 10 becomes ASP 129)



EXPLODED VIEW OF A POSITIONER

ITEM NO.	SPARE PART NO.	NO. OFF	DESCRIPTION
1	SP701	1	ACW COVER ASSEMBLY
	SP702	1	CW COVER ASSEMBLY
2	SP703	1	INDICATOR ASSEMBLY
3	SP704	1	SHAFT SEAL
4	SP705	6	SCREW
5	SP706	1	COVER SEAL
6	SP707	1	ACW FORCE BALANCE LEVER
	SP708	1	CW FORCE BALANCE LEVER
7	SP709	1	SPRING LINK AND NUTS
8	SP710	1	SCREW AND WASHER
9	SP711	1	BOBBIN VALVE ASSEMBLY
10	SP712	1	VALVE BLOCK (03 and 05)
	SP713	1	VALVE BLOCK (07 to 14)
11	SP714	1	VALVE BLOCK GASKET
12	SP715	10	SCREW AND SPRING WASHER
13	SP716	1	SPRING
14	SP717	1	ACW CAM LEVER ASSEMBLY
	SP718	1	CW CAM LEVER ASSEMBLY
15	SP719	1	WASHER AND CIRCLIP
16	SP720	1	DIAPHRAGM COVER
17	SP721	4	SCREW AND SPRING WASHER
18	SP722	1	DIAPHRAGM ASSEMBLY
19	SP723	1	DIAPHRAGM BODY
20	SP724	4	SCREW AND SPRING WASHER

ITEM NO.	SPARE PART NO.	NO. OFF	DESCRIPTION
21	SP725	1	MANIFOLD
22	SP726	1	MANIFOLD GASKET
23	SP727	8	SCREW
24	SP728	1	SILENCER
25	SP729	2	NEEDLE VALVE
26	SP730	1	POSITIONER BOX (03 and 05)
	SP731	1	POSITIONER BOX (07 to 14)
27	SP732	2	SCREW (03 and 05)
	SP733	2	SCREW (07 to 14)
28	SP734	2	'O' RING (03 and 05)
	SP735	2	'O' RING (07 to 14)
29	SP736	1	05 COUPLING
	SP737	1	08 COUPLING
	SP738	1	07, 09, 12 and 14 COUPLING
30	SP739	1	SCREW AND WASHER
31	CAM — SEE ACTUATOR CATALOGUE		