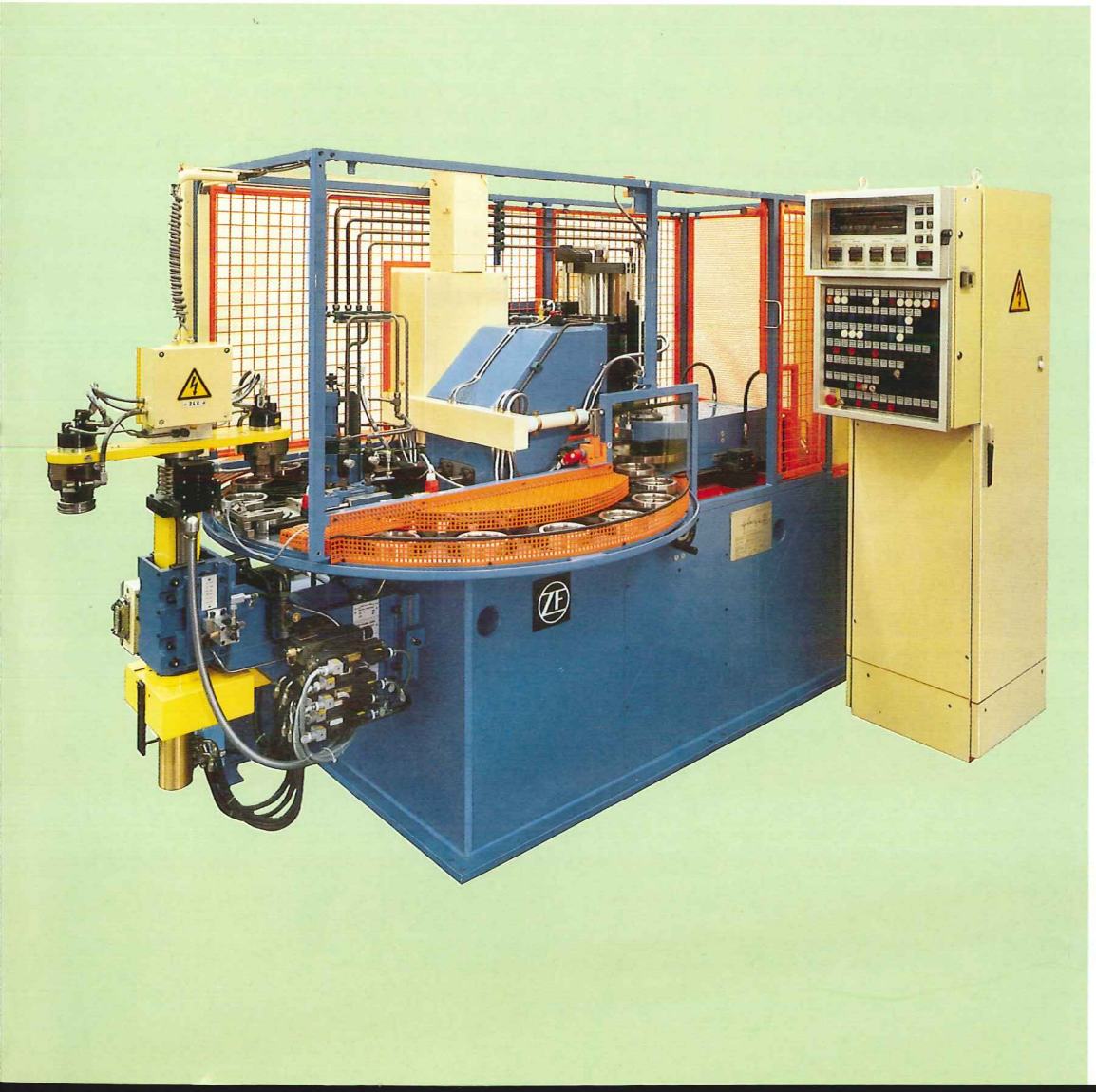
ZF Gear Rolling Machines



ZF Gear Rolling Machines for taper rolling and cylindrical rolling

Zahnradfabrik Friedrichshafen AG's Schwäbisch Gmünd Division, a company of the ZF Group, is Europe's largest enterprise specializing in the field of steering technology. ZF's wide production programme ranges from manual, hydraulic and hydrostatic steerings for all types of vehicles to gearboxes, hydraulic oil pumps, valves, power cylinders, self-locking differentials and accessories for manual and hydraulic steerings.
The company's continuous efforts to improve manufacturing techniques are closely linked to the development of new and more efficient manufacturing processes and the construction of special-purpose machine tools. The ZF Gear Rolling Machine is such a product which bears the marks of ZF's engineering experience and high level of quality.
ZF's engineers offer you their technical advice and assistance in solving your problems. Please write to us if you would like to have further information on ZF's production programme.

Advantages of the gear rolling process:

In the non-cutting rolling process both the taper rolling and the cylindrical rolling are achieved by meshing the rolling gear under pressure with the previously broached, slotted or milled teeth of the workpiece. By a slotting process, sliding sleeves and similar parts with two systems of clutch teeth must undergo four machining cycles to produce the clutch teeth. On a ZF Gear Rolling Machine, the four retaining pockets in the tooth flanks are obtained in a single work cycle.
When milling the cylindrical teeth of clutch discs, several discs can be machined together and then taper rolled individually. In both cases, production times are considerably reduced. ZF Gear Rolling Machines thus contribute to making production more efficient and to cutting costs.

Gear Rolling Machine Model 3 M 2201

Type of rolling:
Rolling of clutch teeth on internal tooth profiles.

Workpieces:
Sliding sleeves, sliding gears and similar parts.

Tool:
Rolling gear, produced to match the workpiece profile to be rolled.

Technical data

Capacity:

Outside diameter of workpiece:
75 to 115 mm
Workpiece width: 16 to 36 mm
(If required, workpieces with larger dimensions can be rolled on a special version of the machine)

Centre distance between workpiece and rolling gear: max. 22 mm

Details as to producible shapes and dimensions, attainable quality grades and required pre-machining can be obtained from our supplementary technical sheet: "Guidelines for the rolling of retaining pockets according to the ZF process -FR-ZK-01-".

Spindle speed: steplessly variable from 30 to 300 min^{-1}

Rolling force: max. 43 kN at 70 bar, steplessly variable

Output on utilization of 100%:
140 to 180 workpieces per hour

Workpiece clamping force:
axially via springs, approx. 4.4 kN

Drive torque: T approx. 200 Nm
(Main spindle drive)

Connected load: ~ 14 kW

Working voltage: 380 V, 50 Hz

Control voltage: 110 V

Valve voltage: 24 V DC

SPS control: 24 V DC

Alternative connected loads on request.

Total floor space required:
approx. 10.5 m^2

Note:

As an addition to their delivery programme, ZF offer machine model 3 M 2203 whose construction is similar to that of the one described below.
This machine is suitable for the external rolling of clutch teeth on gear wheels and clutch bodies.

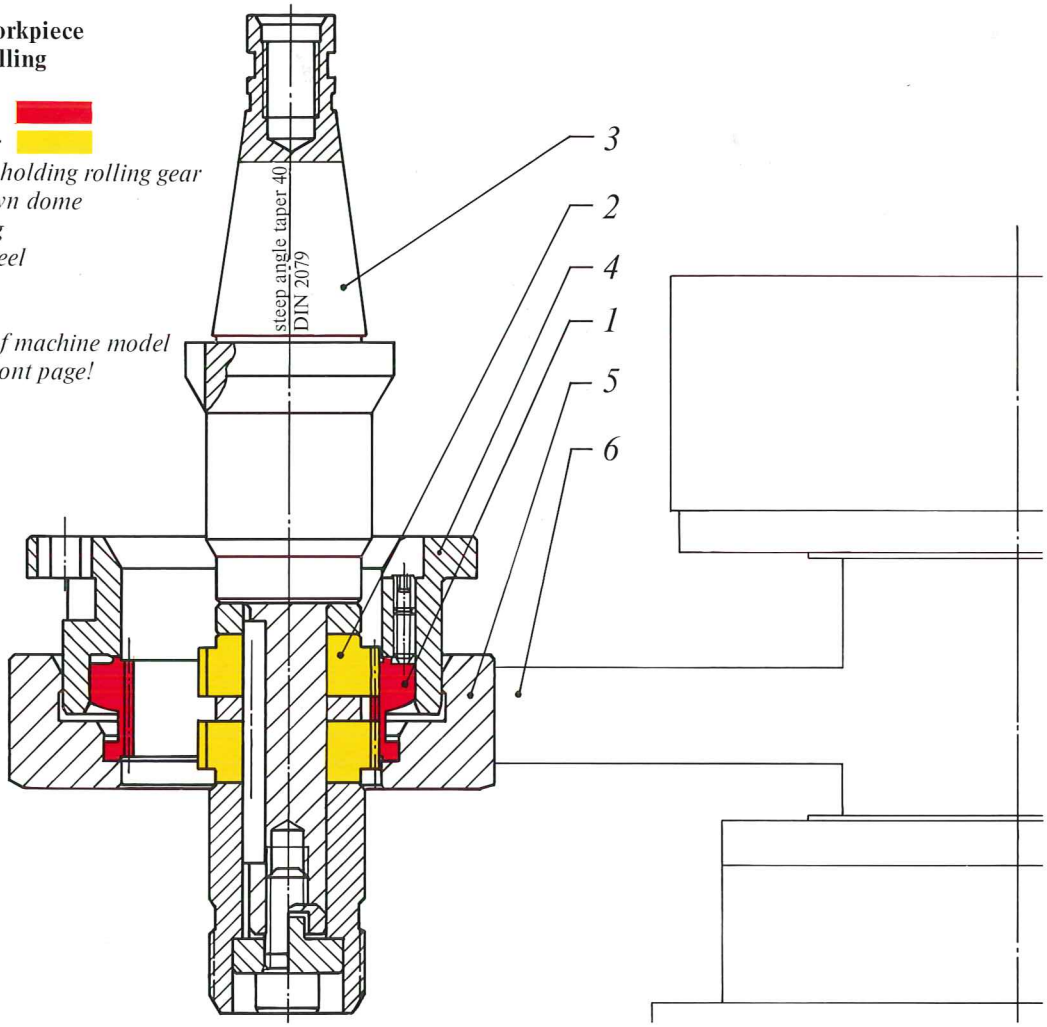
Construction of machine:

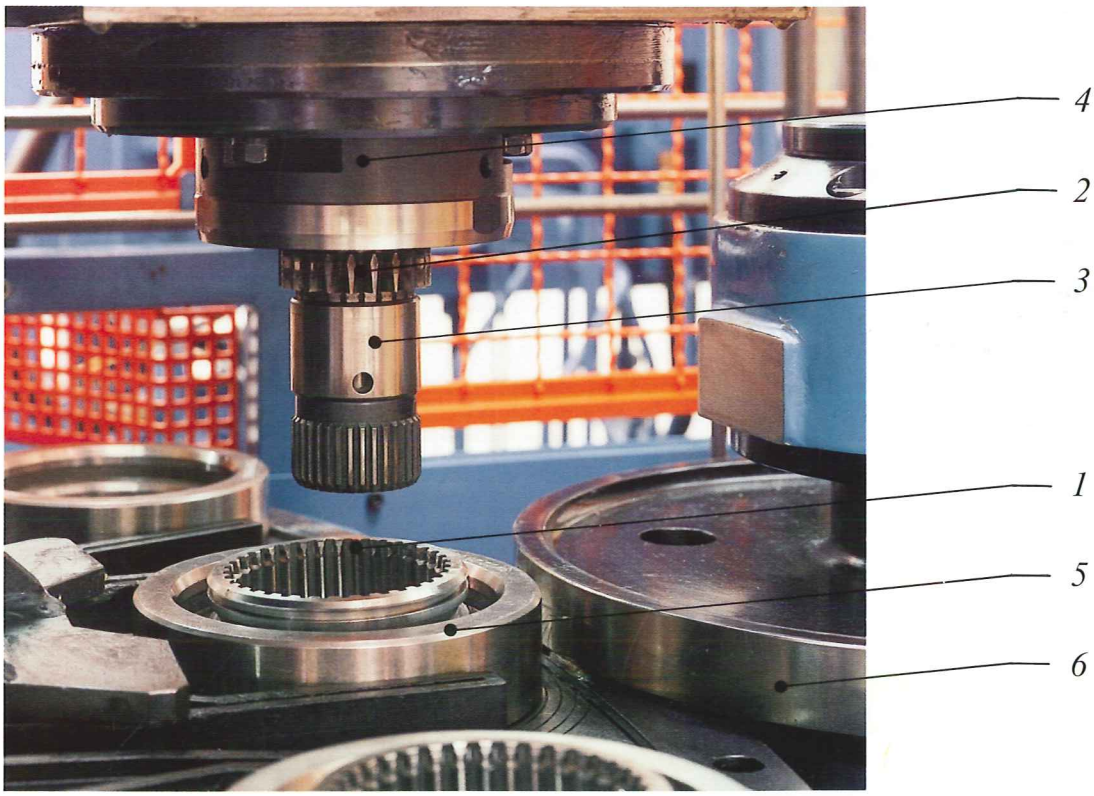
The welded machine bed accomodates the tool spindle, the drive spindle, the rolling slide and the workpiece conveyor ring.
The tool spindle is mounted vertically on the machine bed and driven by a drive spindle with which it is connected through a form fitting connection (multiple-spline shaft connection).
The drive spindle, which is incorporated in the machine bed, is driven by a three-phase current servomotor via a planetary reduction gear (i = 10). The drive spindle serves at the same time as a countersupport to the tool spindle.
To change the workpiece or the tool, a hydraulic cylinder lifts the tool spindle back upwards (lift approx. 150 mm). The holding down dome is provided with a separate slide and fastened to the tool spindle. It presses the workpiece inserted in the holding ring against the supporting plate which is attached to the drive spindle.
According to the centre distance between tool and workpiece, the supporting plate is brought to the required rolling position by means of an adjustment piece. The rolling slide is supported in bronze slideways which are mounted on the machine bed (slide travel max. 22 mm). The rolling depth is adjusted by means of a micrometer screw on the support bracket of the slide (positive stop).
The teeth of the workpiece are meshed with the teeth of the tool in reverse at low force by means of the return cylinder. The workpiece conveyor ring, which is at the same time a small magazine, is driven by a hydraulic motor and accomodates 18 workpieces. The workpieces are put into the holding rings by hand and conveyed on by drive forks. Alternatively, feeding can be automatic, see page 4 of the leaflet.
The coolant and lubricant plants are attached to the machine bed. The coolant flow is monitored by a flow switch and displayed on the control console. Oil level and lubricating pressure of the lubricant plant are monitored electrically and also displayed on the control console.

Location of workpiece for internal rolling

1 Workpiece
2 Rolling gear
3 Mandril for holding rolling gear
4 Holding down dome
5 Holding ring
6 Pressure wheel

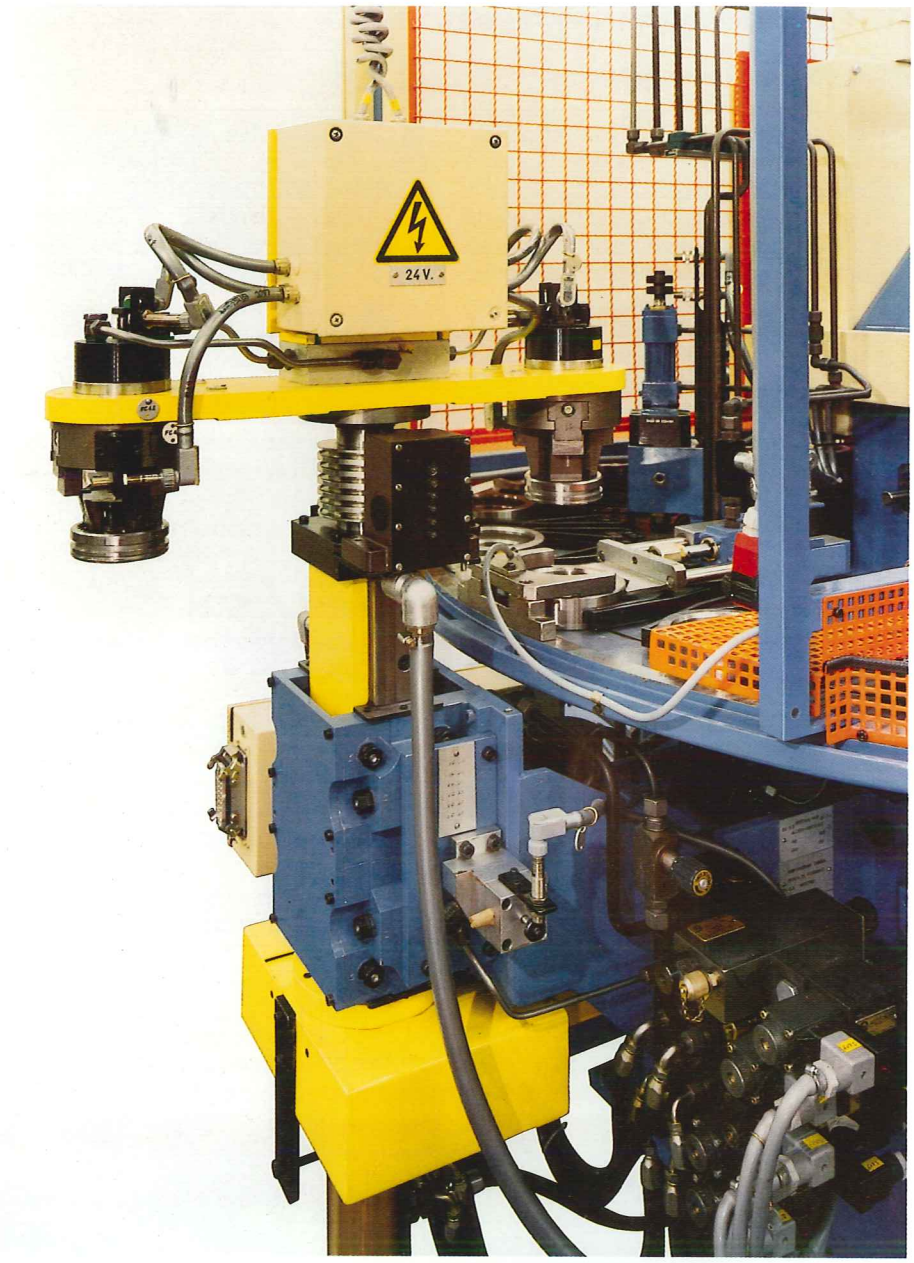
General view of machine model 3 M 2201 on front page!





Work cycle:

The work cycle is fully automatic.
The pre-machined workpiece is taken from the conveyor belt and inserted in the holding ring by the handling appliance mechanism and put down on the conveyor belt again after the rolling operation. Alternatively, feeding can be carried out by hand.
The conveyor ring brings the component into the working station and is held in the correct position by means of a locating cylinder.
The return cylinder travels forwards and centres the holding ring with the workpiece.
The tool spindle with the holding down dome travels downwards. The return cylinder moves back to its initial position, while it advances the workpiece at low force into the teeth of the rolling gear. At the same time the tool spindle starts rotating at reduced speed. The rolling slide moves to rolling position at low starting pressure.
The engagement of the teeth is checked by a limit switch on the rolling slide; this at the same time starts the rolling operation by switching the spindle motor to left-hand rotation. When the full operating speed is reached, rolling pressure "I" is switched on. After expiration of the preselected period of time for left-hand rotation, the machine is switched down to starting pressure so that the sense of rotation can be changed under almost no pressure. After this the period of time for the right-hand rotation at rolling pressure "II" elapses. Before stopping the drive spindle, the machine again switches to starting pressure. The rolling slide travels back. The return cylinder brings the holding ring together with the workpiece back to the initial position. After this the tool spindle with holding down dome is moved back. The conveyor ring removes the rolled workpiece from the working station, simultaneously introducing a new component.



Handling appliance
(compact version)

If desired, the machine can be equipped with a handling appliance.

Technical description

The handling appliance is flange-mounted to the front end of the machine bed. The double-armed grip with the two hydraulically operated clamping tongs is driven by a hydraulic oscillating motor and accurately positioned by positive stops. On request, a single-track conveyor belt can be supplied which offers the workpieces to the handling appliance one by one and accurately positioned.

Operation

The pre-machined workpiece on the belt and the finished part in the machine are simultaneously taken up by a vertical movement of the grip and put down again after a swing through 180°.

Technical data

The height at which the workpiece is placed in readiness is 1011 mm, measured from floor to lower edge of workpiece. The hydraulic operating pressure is 40 bar.

Gear Rolling Machine Model 3 M 2204

Type of rolling:
Rolling of clutch teeth on internal and external tooth profiles.

Workpieces:
Sliding sleeves, gear wheels, clutch bodies, clutch discs and similar parts.

Tool:
Rolling gear, produced to match the workpiece profile to be rolled.

Technical data

Internal rolling:

Outside diameter of workpiece:
75 to 250 mm
Workpiece width: 16 to 55 mm
Centre distance between rolling gear and workpiece: max. 40 mm

External rolling:

Outside diameter of workpiece:
max. 250 mm
Smallest possible pitch diameter that can be worked: 65 mm
Centre distance between rolling gear and workpiece: 210 to 250 mm

Details as to producible shapes and dimensions, attainable quality grades and required pre-machining can be obtained from our supplementary technical sheet: "Guidelines for the rolling of retaining pockets according to the ZF process -FR-ZK-01-".

Spindle speed: steplessly variable from 30 to 300 min^{-1}

Rolling force: max. 68 kN at 110 bar, steplessly variable

Output on utilization of 100%:
80 to 120 workpieces per hour, depending on the pitch diameter

Workpiece clamping force:
axially via springs, approx. 4.4 kN

Drive torque: T approx. 200 Nm
(Main spindle drive)

Connected load: ~ 14 kW

Working voltage: 380 V, 50 Hz

Control voltage: 110 V

Valve voltage: 24 V DC

SPS control: 24 V DC

Alternative connected loads on request.

Total floor space required: approx. 6.2 m^2

Construction of machine:

The welded machine bed accomodates the tool spindle, the drive spindle and the rolling slide.
The tool spindle is mounted vertically on the machine bed and driven by a drive spindle with which it is connected through a form fitting connection (multiple-spline shaft connection).
The drive spindle, which is incorporated in the machine bed, is driven by a three-phase current servomotor via a planetary reduction gear (i = 10). The drive spindle serves at the same time as a countersupport to the tool spindle.
To change the workpiece or the tool, a hydraulic cylinder lifts the tool spindle back upwards (lift approx. 160 mm). The holding down dome is provided with a separate slide and fastened to the tool spindle. It presses the workpiece inserted in the holding ring against the supporting plate which is attached to the drive spindle.
According to the centre distance between tool and workpiece, the supporting plate is brought to the required rolling position by means of an adjustment piece (positive stop).
The rolling slide is supported in bronze slideways which are mounted on the machine bed (slide travel max. 40 mm).
The rolling depth is adjusted by means of a micrometer screw on the support bracket of the slide.
The rear stop for the rolling slide is adjusted so that the holding ring in its initial position is centrically aligned with the tool spindle.
By means of the return cylinder the teeth of the workpiece are meshed with the teeth of the tool at low force.
The coolant and lubricant plants are attached to the machine bed. The coolant flow is monitored by a flow switch and displayed on the control console.

Work cycle

The work cycle is to a large degree automatic.

For internal rolling
the workpiece is inserted in the holding ring by hand and the protective door shut. The return cylinder advances and centres the holding ring with the workpiece. The tool spindle moves down. The return cylinder moves the holding down dome together with the workpiece and holding ring backwards until the rolling gear teeth are brought into engagement with the workpiece teeth. Meanwhile rotation of the tool spindle is started at low speed.

For external rolling
the workpiece is inserted in the machine by hand bringing it at once into engagement with the rolling gear.
The holding down device comes down clamping the workpiece while the return cylinder is switched off.

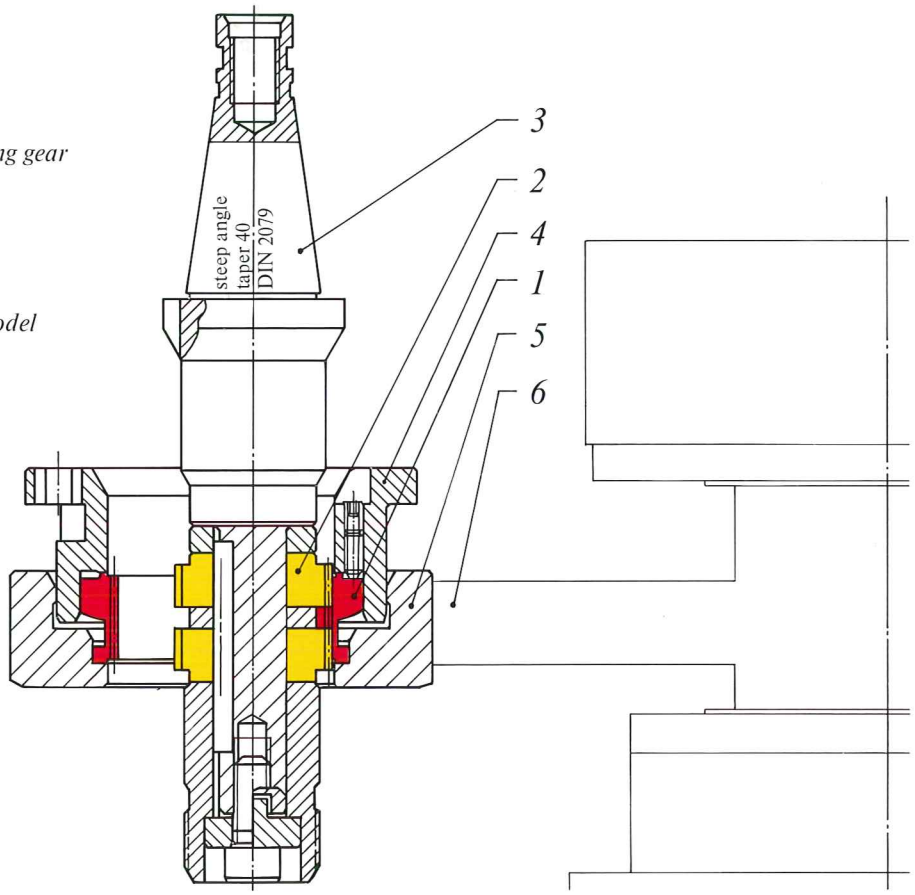
The further work cycle is identical for both types of rolling:

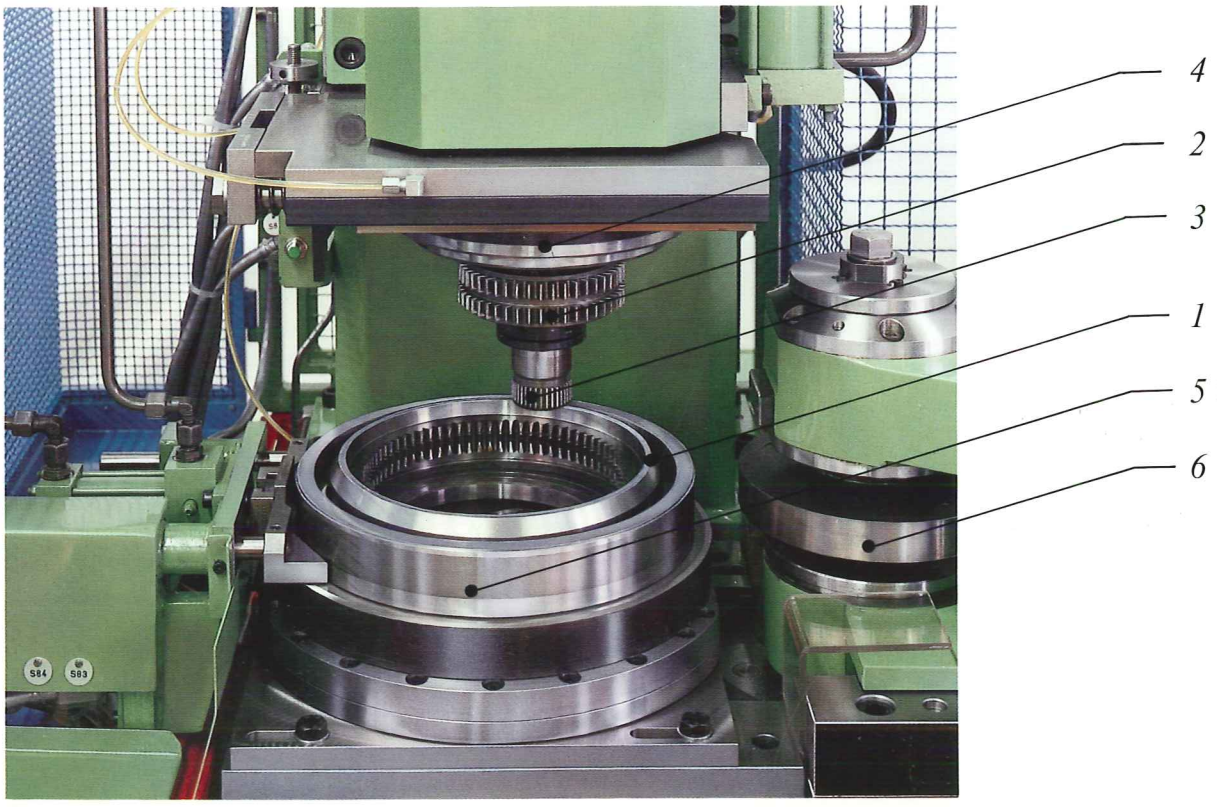
The rolling slide advances at low starting pressure. Simultaneously the rolling operation is started through a limit switch of the rolling slide by switching the spindle motor to left-hand rotation.
After the full operating speed is reached, rolling pressure "I" is switched on. When the preselected period of time for left-hand rotation is expired, the machine is switched down to starting pressure so that the sense of rotation can be changed under almost no pressure.
After this the time for the right-hand rotation at rolling pressure "II" elapses. Before the drive spindle is stopped, the machine is again switched to starting pressure.
The rolling slide travels back. In the internal rolling operation, the return cylinder takes the holding ring together with the workpiece back to the initial position. After this, the tool spindle with the holding down dome is moved back.
The protective door can now be opened to remove the worked component.

Location of workpiece for internal rolling

1 Workpiece
2 Rolling gear
3 Mandril for holding rolling gear
4 Holding down dome
5 Holding ring
6 Pressure wheel

General view of machine model 3 M 2204 on page 8!





Location of workpiece for external rolling

1 Workpiece
2 Rolling gear
3 Rolling gear locating fixture
4 Draw-in mandril
5 Support sleeve