4. MAIN MACHINE UNITS

4.1 Work Station

The work station is equipped with the following main units:

a.) Swaging unit:

Plunge swaging machine UR5-4DD with

- mandrel and pusher device

b.) Feeder unit:

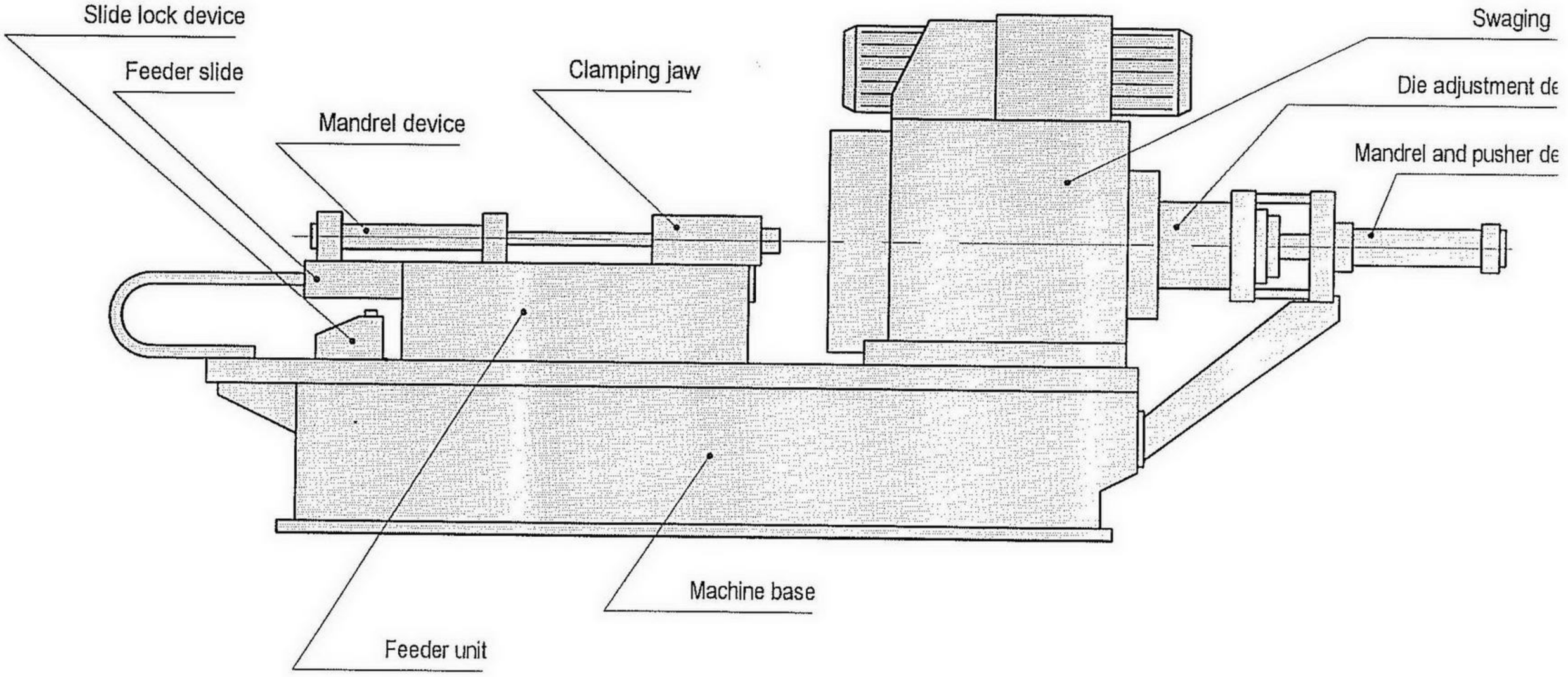
Hydraulic feeding system 24H with

- hydraulic clamping jaw

- mandrel device

- feeder slide lock device

SWAGING MACHINE UR5-4DD: Main Units



4.1.1 SWAGING MACHINE UR5-4DD

4.1.1.1 Application

Tubular Steering Shafts P/N 26061039, P/N 26052084 and P/N 26061697:

- Operation No. 1: plunge / return feed swaging

  swaging o.d. ∅25.311 / 25.489 mm

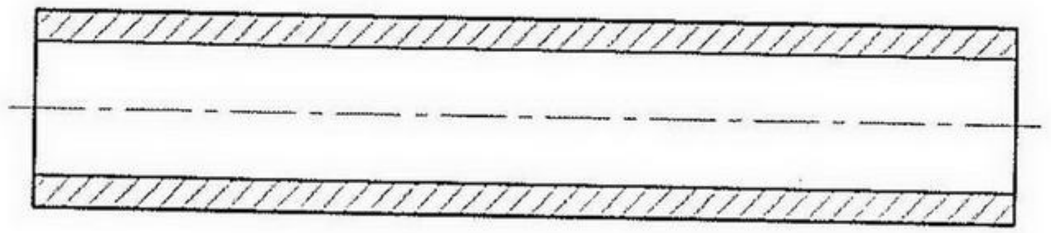
- Operation No. 2: infeed swaging

  swaging internal spline

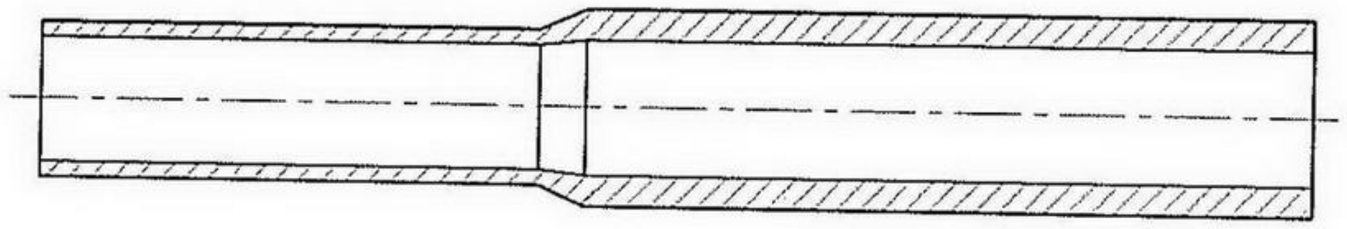
- Operation No. 3: infeed swaging

  swaging „Double-D“ form

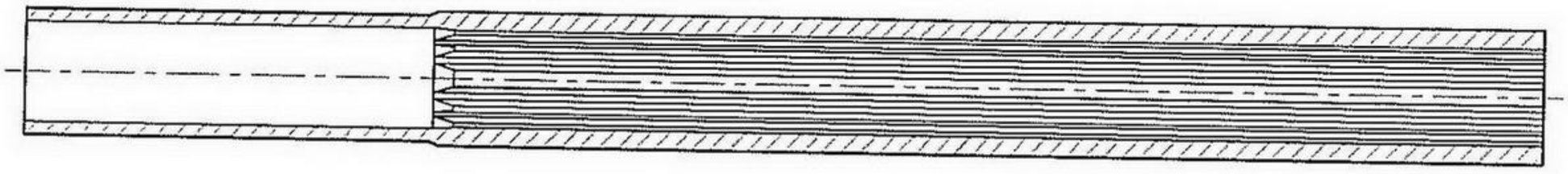
0: Tube blank



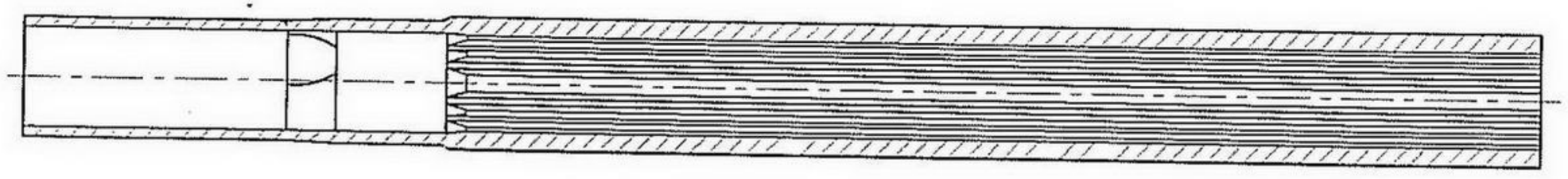
Op. No. 1, plunge / return feed swaging: swaging ø 25.311 / 25.489 mm



Op. No. 2, infeed swaging: swaging internal spline



Op. No. 3, infeed swaging: swaging "Double-D" form



Freimaße: DIN 7168 fein			Maßstab	Werkstoff	Stück
	Datum	Name			
Gez.	01.08.96	pi	Benennung	TUBULAR STG. SHAFT	
Gepr.				P/N 26061039 / 26052084 / 26061697	
HMP Heinrich Müller			Verwendung	RAMCO	
			Zeichnung Nr.		

4.1.1.2 Important technical data

a.) Applicable diameter range:

- Bars: ∅ 5.0 - 30.0 mm

- Tubes: ∅ 5.0 - 60.0 mm

These dimensions refer to steel of medium tensile strength ($\sigma \approx 600$ N/mm²) and with sufficient elongation.

b.) Dimensions of the swaging dies: 50 x 55 x 120 mm (w x h x l)

c.) Drive of machine shaft and steel ring:

- Pulleys for machine shaft: ∅ 90 / ∅ 650 mm

- Pulleys for steel ring: ∅ 110 / ∅ 650 mm

- Drive motor for machine shaft: 8.6 kW; 865 r.p.m

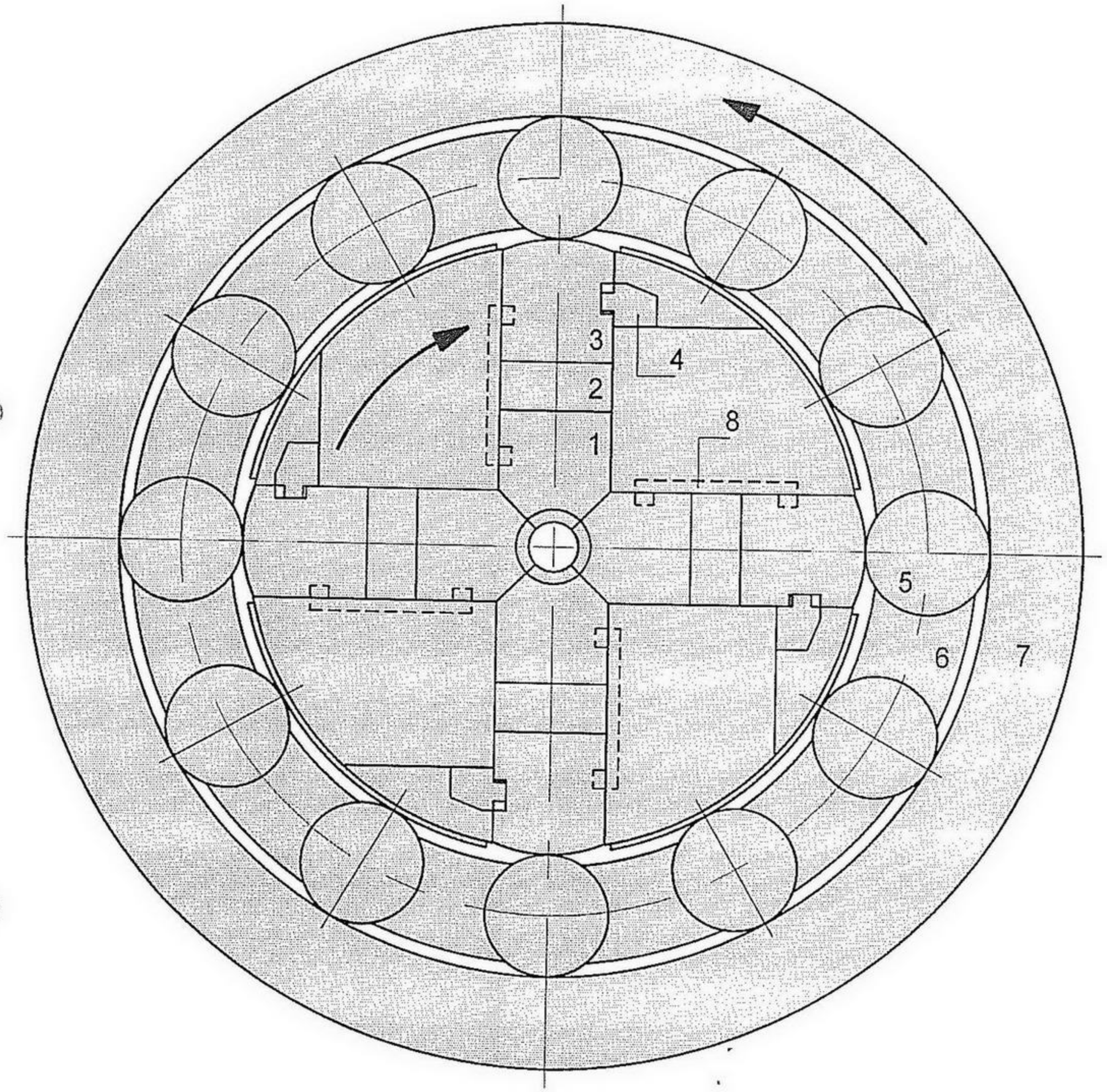
- Drive motor for steel ring: 18 kW; 1160 r.p.m

- Speed of machine shaft: 120 r.p.m

- Speed of outer steel ring: 200 r.p.m

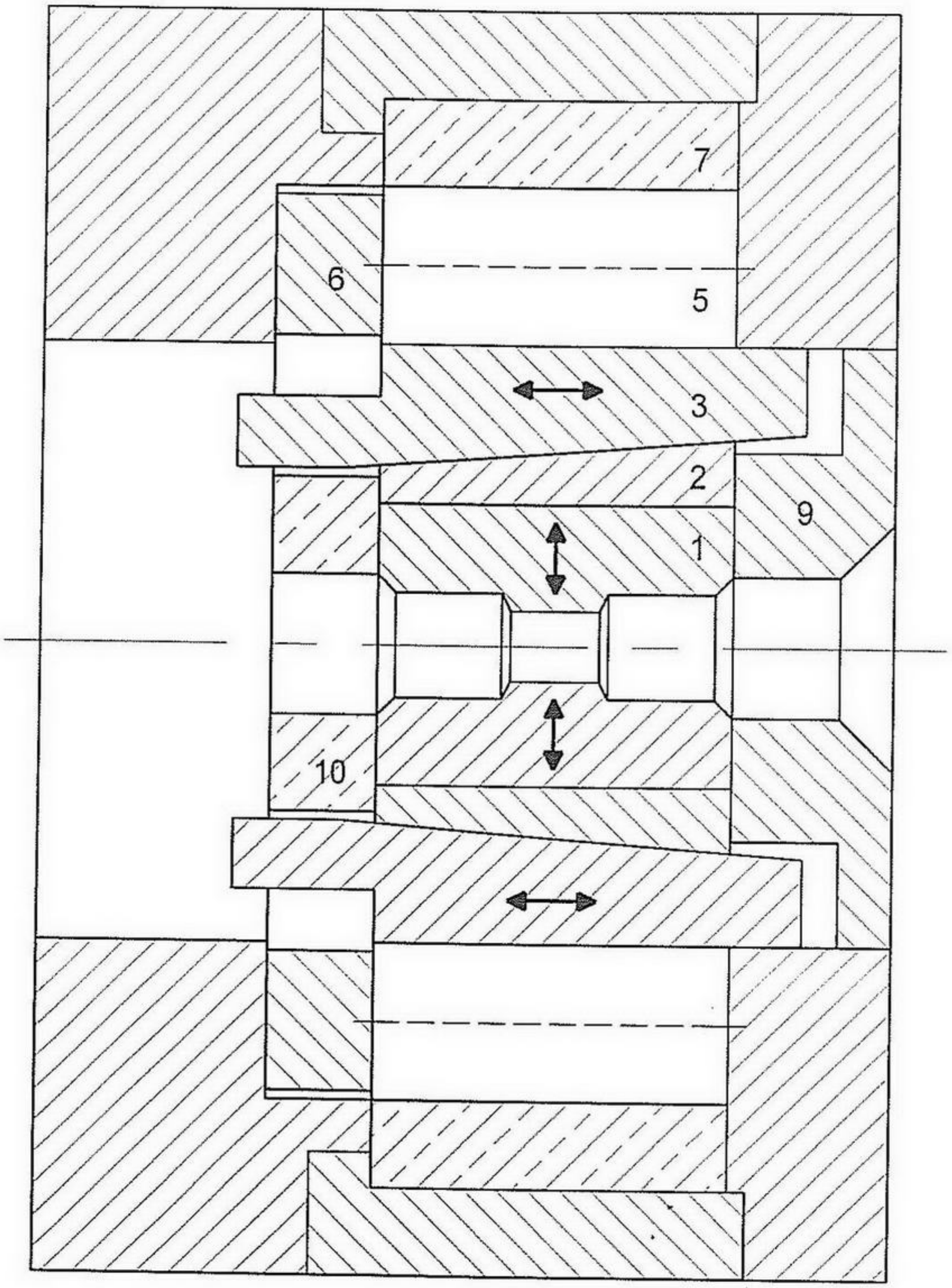
d.) Stroke frequency: 1830 strokes / min.

Machine used for plunge swaging operations
(Operations No. 1 and 3 on Tubular Stg. Shafts P/N 26052084, etc.)



1. Swaging Dies
2. Wedges
3. Outer Strikers
4. Stroke Limitation Keys
5. Rollers
6. Roller Cage
7. Steel Ring
8. Guide Plates

Machine used for plunge swaging operations
(Operations No. 1 and 3 on Tubular Stg. Shafts P/N 26052084, etc.)



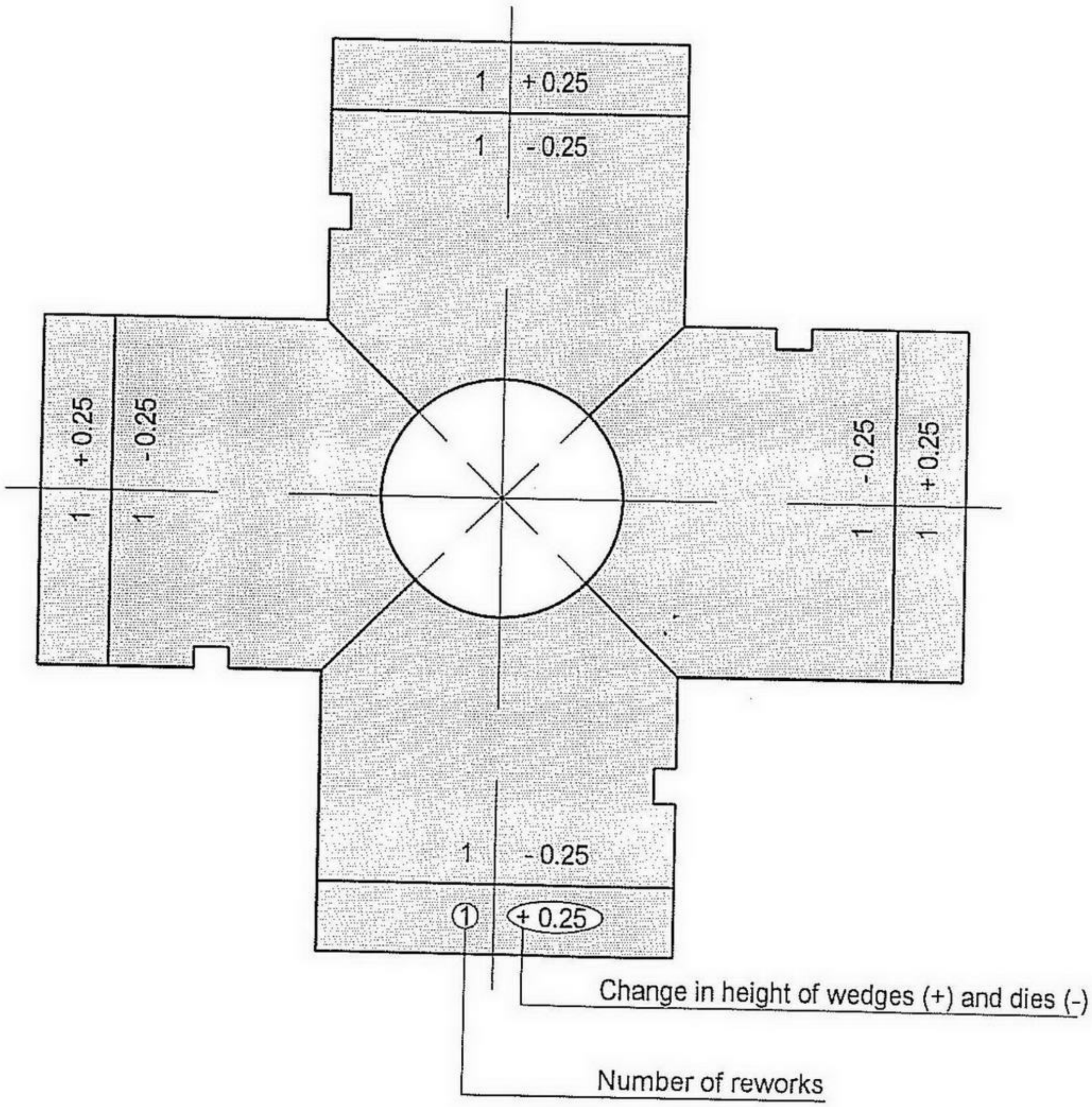
1. Swaging Dies
2. Wedges
3. Outer Strikers
5. Rollers
6. Roller Cage
7. Steel Ring
9. Cover Plate
10. Cross Plate

CAUTION

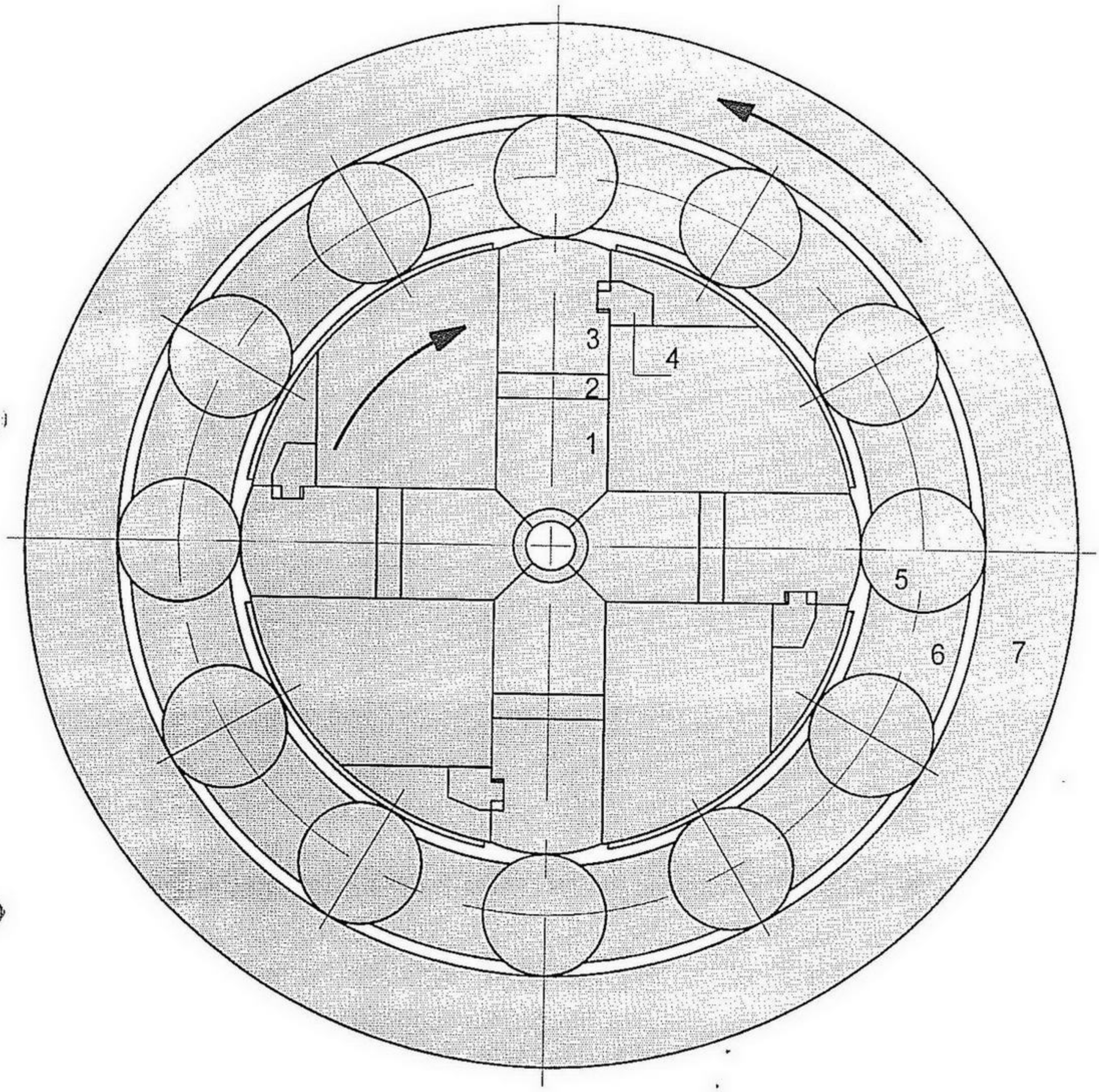
Reworking swaging dies reduces the height of the dies. This difference in height is to be compensated by use of the corresponding wedges. These wedges must be higher by the same amount the dies have been reduced in height.

In case of installing reworked dies, it is very important that the wedges are also replaced.
The number of reworks carried out on the swaging dies as well as the difference in height is stamped on the upper flats of the dies.
The wedges to be installed together with reworked dies are on their front face marked with the same number and with the same amount of difference in height.

Using dies together with wedges on which the number of reworks does not correspond to each other may damage the inside parts of the machine.
After replacement of dies and wedges, prior to starting the machine the oscillation stroke of the dies is to be checked by rotating the machine shaft slowly and carefully.

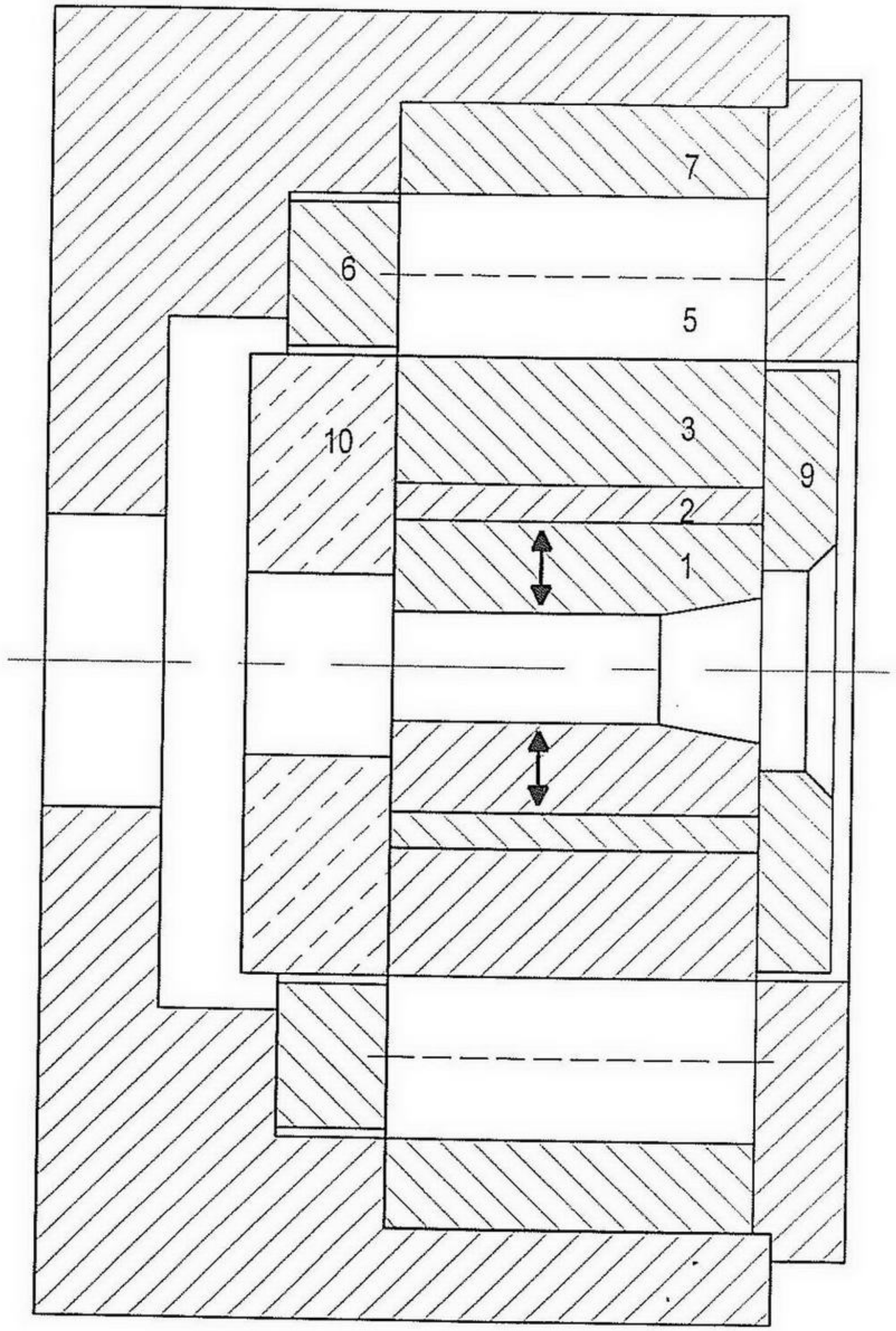


Machine used for infeed swaging operations
(Operation No. 2 on Tubular Stg. Shafts P/N 26052084, etc.)



1. Swaging Dies
2. Shims
3. Outer Strikers
4. Stroke Limitation Keys
5. Rollers
6. Roller Cage
7. Steel Ring

Machine used for infeed swaging operations
(Operation No. 2 on Tubular Stg. Shafts P/N 26052084, etc.)



1. Swaging Dies
2. Shims
3. Outer Strikers
5. Rollers
6. Roller Cage
7. Steel Ring
9. Cover Plate
10. Cross Plate

4.1.1.3 Operating Principle

This machine is a special type of rotary swaging machines, a so-called external and internal rotating machine with plunging ("DD") device.

The machine may alternatively be used as a plunge swaging machine or as an infeed swaging machine.

4.1.1.3.1 Plunge Swaging

The dies (1) oscillate permanently in radial motion. Every time one set of rollers (5) passes over one set of strikers (3) one radial forming stroke is executed.
The outer strikers (3) in the swaging shaft are pressed in direction of dies (1) and workpiece when passing underneath the rollers (5). The movement of the outer strikers (3) is transmitted to wedges (2) and dies (1). When the outer striker (3) has left contact with the roller (5), die (1) and striker (3) move radially outwards by centrifugal force.

The outer steel ring (7) and the main shaft both rotate, normally in opposite directions.
The work frequency is mainly created by the quickly rotating outer steel ring (7).
The swaging shaft rotates with slow speed.
Both the steel ring as well as the swaging shaft are driven by electric motors.

Special cinematic elements only used in HMP swaging machines effect rollers (5) to rotate without slip. The roller cage (6) also rotates in direction of the steel ring with half value of the peripheral speed. The kinematics are roughly similar to roller bearings.

The oscillation stroke of the outer strikers or the oscillation stroke of the opening and closing movement of the dies respectively can be altered by using stroke limitation elements (4) of different heights. These stroke limitations are inserted into the groove on the right hand side of the outer strikers.

The supplementary radial die adjustment device enables to carry out plunge swaging operations.
In addition to the small and quick radial die oscillations, the dies execute a larger radial movement during plunge swaging.
The movement of the workpiece is restricted to loading the part into axial position for the swaging operation (no feeding movement during the actual swaging operation). When the workpiece is loaded, the swaging operation takes place combining the small radial oscillating movement of the dies and the larger radial closing movement.

When the dies are closed under the rollers, they tend to turn and twist the workpiece. These forces are compensated by controlled slip in the clamping jaws using a clamping mechanism with adjustable force.

The radial die adjustments are executed hydraulically. The outer strikers (3) with a taper on the lower surface are shifted in axial direction. The radial adjustment of the dies (1) is made with the aid of the shims (2) which have a tapered upper surface.

The diameters produced on the workpiece can be corrected by adjusting the front stop position or the longitudinal stroke respectively of the tapered outer strikers (3). This adjustment is carried out by altering the position of the stop ring at the rear of the machine or by altering the stroke of the hydraulic cylinder for the axial movement of the outer strikers respectively.

4.1.1.3.2 Infeed Swaging

If required, this plunge swaging machine can also be employed as an "infeed" machine with the swaging dies remaining closed permanently (die adjustment device inoperative).

The dies oscillate permanently in radial motion. Every time one set of rollers (5) passes over one set of outer strikers (3), one radial forming stroke is executed.

The outer strikers (3) in the swaging shaft are pressed in direction of dies (1) and workpiece when passing underneath the rollers (5). The movement of the outer strikers (3) is transmitted to shims (2) and dies (1). When the outer striker (3) has left contact with the roller (5), die (1) and striker (3) move radially outwards by centrifugal force.

The oscillation stroke (not the radial adjustment stroke) of the outer strikers and dies can be altered by using stroke limitations (4) of different heights. These stroke limitations are inserted into a groove on the side of the outer strikers.

The workpiece is pushed axially at a constant rate of speed through the oscillating dies. Actually the workpiece infeed takes place when the rollers (5) are between the strikers (3), i.e. strikers and rollers are not touching, as only during this time the dies are open. The actual workpiece feed is therefore a high frequency pulsating axial movement.

When the dies are closed under the rollers, they tend to turn and twist the workpiece. These forces are compensated by controlled slip in the clamping jaws using a clamping mechanism with adjustable force.

4.1.1.3.3 Combination plunge / infeed swaging

In addition to the above two swaging principles, the machine allows to use a combination of plunge swaging together with infeed swaging.

When using this combination, the workpiece is moved between the opened swaging dies into the axial loading position.
After the dies are closed, the workpiece is moved between the closed dies in axial direction.

After plunging in, the workpiece can either be pulled fully out of the machine through the closed dies (plunge / return feed swaging).
Alternatively after closing the dies the workpiece can be moved back up to a certain position only, i.e. not fully through the dies out of the machine, and then the swaging dies open and subsequently the workpiece is moved out of the machine through the opened dies. This method for instance enables to reduce cross-sections between to larger ends.

The individual swaging methods can be pre-selected by a switch on the control panel. The operation sequence then is carried out automatically in the corresponding order.

4.1.1.4 Change Over from Plunge Swaging to Infeed Swaging

When changing over from a plunge swaging operation to an subsequent infeed swaging operation (not in case of changing over to a plunge and infeed swaging combination program), the following parts of the swaging head are to be changed:

a.) Change over from plunge to infeed swaging:

- tapered outer strikers are to be replaced by outer strikers with straight lower surface

- wedges are to be replaced by shims

- install corresponding swaging dies

- guide plates are to be removed (not required for infeed swaging)

- install corresponding stroke limitation keys

- cross plate to be replaced by corresponding cross plate for infeed swaging

- cover plate is to be replaced by corresponding cover plate for infeed swaging

- select on the control panel infeed swaging program

1. RECORD CARD

Description: Semi-automatic 1-Station Swaging Machine	Type: UR5-4-DD-24H	Date of order: April 1996
Manufacturer: Heinrich Müller, Pforzheim	Serial No: 5164	Order No.: 3377RC
Supplier: Heinrich Müller, Pforzheim	Year built: 1996	Date of delivery: July 1996

Specification	Customer
WORK STATION: a.) Plunge swaging machine UR5-4DD-N2 with: - interchangeable 4-die swaging head UR5-4DD-A-3/1 - mandrel and pusher device UR5-4DD-N1-05-300 b.) Feeder unit: - Hydraulic feeding system 24H-4050-03-100 - Hydraulic clamping jaw 24H-4005-01-200 (piston ∅40 mm) with rotating stop 24H-21-200 and workpiece orientation system - Mandrel device 24H-4055-00-600 on the feeder slide - Feeder slide lock device 24H-5025-00-800	RAMCO Manufacturing Company 1101 Oren Drive Auburn, IN 46706 - USA **Especially suitable for** - Tubular Stg. Shaft P/N 26061039 - Tubular Stg. Shaft P/N 26052084 - Tubular Stg. Shaft P/N 26061697

Type of Drive	Voltage: 3 x 460 V	Frequency: 60 Hz	Date issued: 31.07.1996				Name: pi.	
Motor for	Manufacturer	Type / No.	Style DIN 42950	cos φ	Power kW	Current A	R.P.M.	Protect. system
Machine shaft	Siemens	1LA5166-8CB61	B 5	0.73	8.6	17.3	865	IP 55
el ring	Siemens	1LA5186-6AA61	B 5	0.83	18	30.5	1160	IP 55

Main Drive		
Pulley Diameter:	Shaft (∅ drive pulley / ∅ flywheel): ∅ 90 / ∅ 650 mm	Steel ring (∅ drive pulley / ∅ flywheel): ∅ 110 / ∅ 650 mm
R.P.M.:	Shaft: 120 rpm Steel ring: 200 rpm	
Stroke Frequency:	1830 strokes / min.	
V· ''s:	Shaft: 4 pcs. SPA LW 2650, Continental Steel ring: 5 pcs. SPA LW 2682, Continental	

Remarks / Miscellaneous

Outer strikers:
a.) for plunge swaging operations: material A30, 6°
b.) for infeed swaging operations: material CP, 0°