Bearing arrangement for rolls in a 155 t calender for PVC floor coverings

Examples from Application Engineering

WL 03 503 GB-D

Manufacturer: Rodolfo Comerio

Operator: Taraflex

In 1986, French company Taraflex commissioned a calender, manufactured by Rodolfo Comerio, S.N.C., Solbiate Olona/Italy, for PVC floor coverings.
The rolling bearings used in this bearing arrangement concept were supplied by FAG and have since been operating smoothly around the clock. The thermoplastic material passes through the gaps between rolls 1 and 2, rolls 2 and 3 and rolls 3 and 4, during which process its thickness is gradually reduced.
Hot water flowing through the rolls heats their outside surfaces up to +220 °C, thereby achieving good processibility of the plastic mass.
The main bearings in rolls 1, 2 and 4 support the radial rolling forces. The main bearings in roll 3 are only subjected to the difference between the rolling forces of rolls 2 and 4.
Rolls 1, 2 and 4 undergo flexing under the high forces in the rolling gap. In order to keep the thickness tolerance of the rolled material in the micrometer range, flexing is compensated by tilting the axes of rolls 1 and 3 and counterbending of rolls 2 and 4.
The narrow thickness tolerance calls for an extremely high level of bearing running accuracy and sufficiently clearance-free, radial guidance of intermediate roll 3, which is only exposed to the low differential load.

The bearing concept is based on a solution which has been proven in other calender applications.
The rolling forces, distortions of roll body, roll neck and bearings, as well as the bearing temperatures reached during processing of various types of plastics, have also been taken into account.

In this bearing concept, the bearings meet all requirements, such as:

- reliable accommodation of forces
- good axial and radial guidance
- accommodation of the counterbending forces
- extremely high running accuracy
- high temperature suitability and dimensional stability.

Type:	Four-roll calender, F form
Useful width:	3 600 mm
Roll diameter:	820 mm
Roll gap: 1st step	1,5 mm to 2 mm
2nd step	1 mm to 1,5 mm
3rd step	0,25 mm to 1 mm
Roll speed:	6 rpm to 24 rpm
Roll mass:	18 000 kg

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Bearing system

The bearing system comprises:
- the main bearing arrangement for supporting radial and axial forces, which is identical for all rolls
- the “roll bending bearing arrangement” in rolls 2 and 4 for accommodating the counterbending forces
- the preload bearing arrangements for clearance-free guidance of intermediate roll 3.

Main bearing arrangement

The bearing support load of rolls 1, 2 and 4 resulting from the maximum gap load of 5 kN/cm and the roll mass is supported at both ends by two double row cylindrical roller bearings.
A radially relieved deep groove ball bearing in the locating bearing arrangement at the drive end guides the roll axially.
Angular misalignment due to shaft flexing (and possible roll inclination) is compensated by a spherical cap between machine frame and bearing housing.
As a result of the operating temperature, which under roll surface temperatures of, for example, +220 °C can reach up to +160 °C at the inner ring, all rolling bearings have to be appropriately heat treated and dimensionally stable up to +200 °C.
The required high runout accuracy of the rolls of ≤ 5 µm is achieved not only by high bearing precision (P5 running accuracy) but also by finish-grinding the bearing inner rings and roll bodies in one clamping operation at the anticipated roll operating temperature of, for example, +220 °C.
The calculated finish-grinding dimension of the inner ring raceway is defined such that the resulting radial internal clearance permits a temperature gradient of +80 °C between outer and inner ring without the risk of generating a radial preload during the heating stage.

Roll bending bearing arrangement

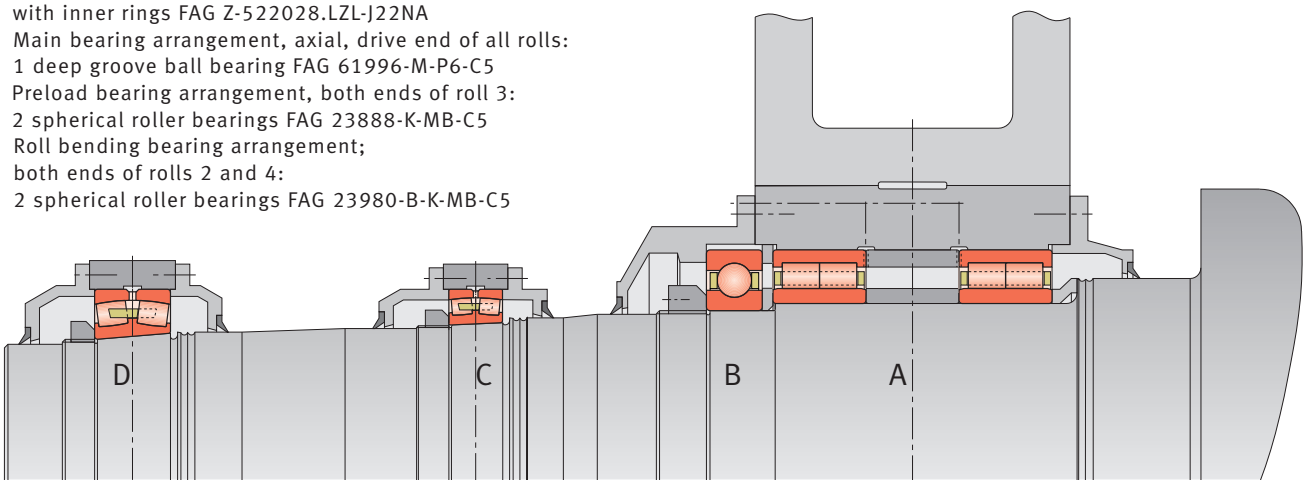
Hydraulic cylinders at both ends of the roll apply a maximum roll bending force of 345 kN to the roll necks, thus generating counterbending of the rolls. The force is transmitted from the hydraulic cylinders to the roll necks via the housing and spherical roller bearings.

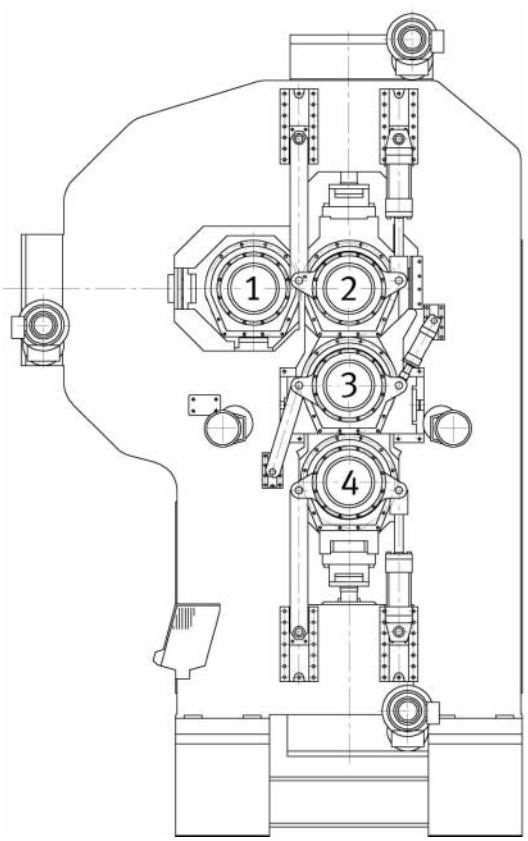
Preload bearings

The main bearings in roll 3 are subjected to the weight and the difference between the rolling forces from gaps 2 and 3.
The resulting force may act from above or below and may also be relatively small. Uncontrolled radial roll movements under the so-called zero crossing and slippage conditions are prevented, whereby the main bearings are generally subjected to a radial load of 100 kN by the preload bearings.

Bearing system in a 155 t calender (bearings per roll)

A Main bearing arrangement, radial, at both ends of all rolls:
2 cylindrical roller bearing pairs comprising
FAG Z-522028.RZL-N12BC-M15FC
with inner rings FAG Z-522028.LZL-J22NA
B Main bearing arrangement, axial, drive end of all rolls:
1 deep groove ball bearing FAG 61996-M-P6-C5
C Preload bearing arrangement, both ends of roll 3:
2 spherical roller bearings FAG 23888-K-MB-C5
D Roll bending bearing arrangement;
both ends of rolls 2 and 4:
2 spherical roller bearings FAG 23980-B-K-MB-C5





Roll arrangement in calender from Rodolfo Comerio, type F

Lubrication

The lubricant is subjected to severe stress. Due to the low speed, no elastohydrodynamic lubricant film can form. The high operating temperature, which reduces viscosity and accelerates the ageing of the oil, constitutes a further problem.
The bearings constantly operate in the mixed friction range and are exposed to increased wear.
Polyglycol oils, which exhibit high thermal stability and resistance to ageing, offer protection against wear and have been used successfully under these conditions.
A central recirculating lubrication system with recooling supplies all roll bearing arrangements with sufficient quantities of oil. For the cylindrical roller bearings, the oil is fed through grooves in the housing and radial lubricating grooves in the end face of the outer ring, as well as laterally for deep groove ball bearings and centrally for the spherical roller bearings.

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