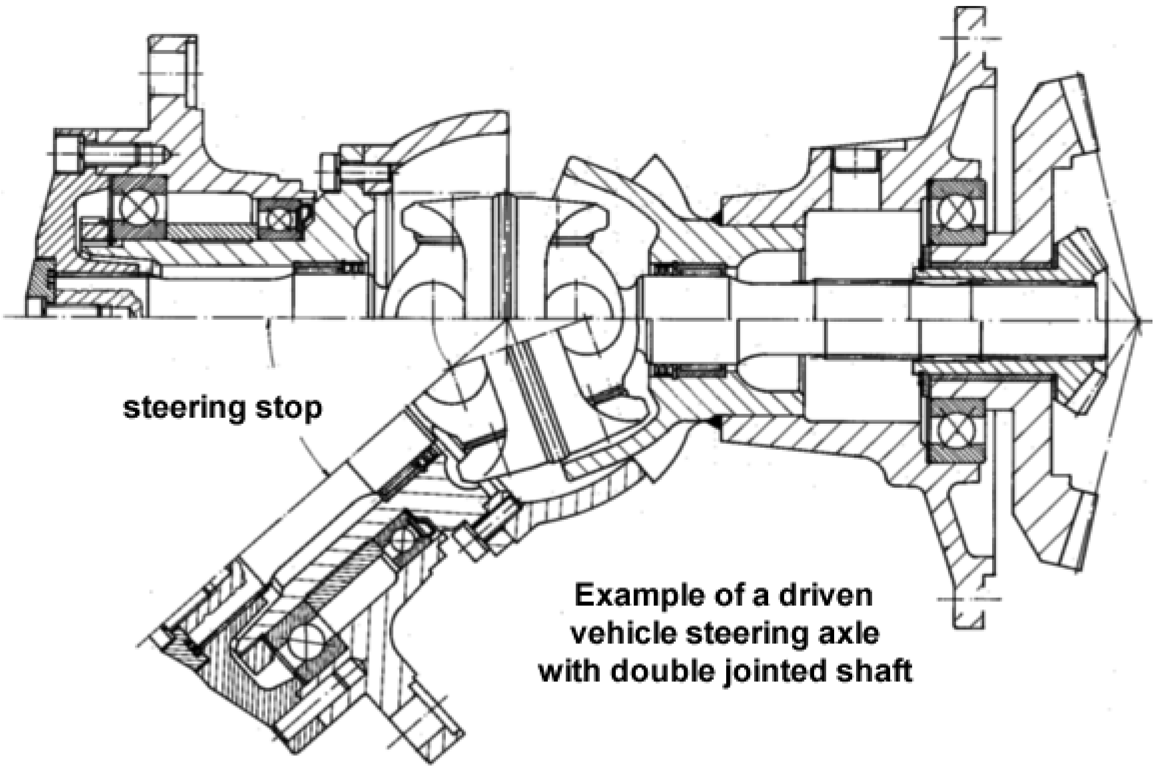
Features of the Double Joint

Double joints are used to drive steerable rigid axles. Their main area of application is all-wheel drive goods vehicles. The dimensioning criteria below therefore relate to this area.

Fig.26:



9.1 Axial Movement of Drive Shaft on Turning

In Fig. 27, 1 represents the fixed bearing driven shaft, 2 the mobile bearing drive shaft. A and B are joint bearings, 0 is the pivot pin axle.

If the joint is fitted such that rotation point 0 of the pivot pin axle agrees with centre point M of the extended joint, with the joint bent by deflection angle ß, unequal deflection angles $ß_1$ and $ß_2$ occur and hence unequal transmission as shown in Fig. 29 curve $ß_0$ = 0° and y = 0.

Fig. 27:

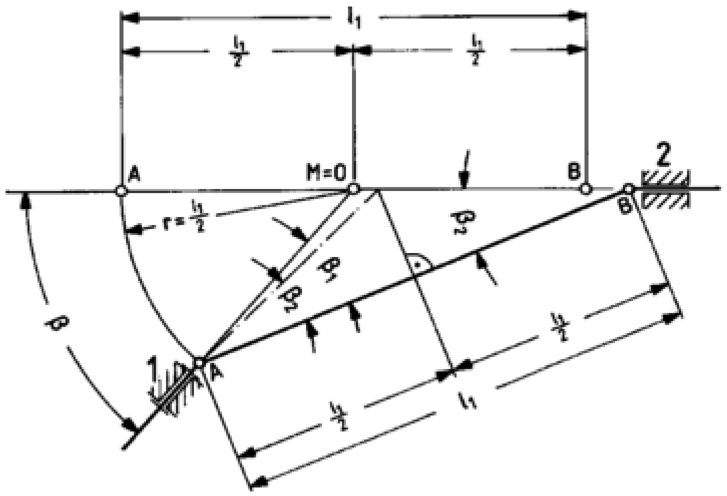
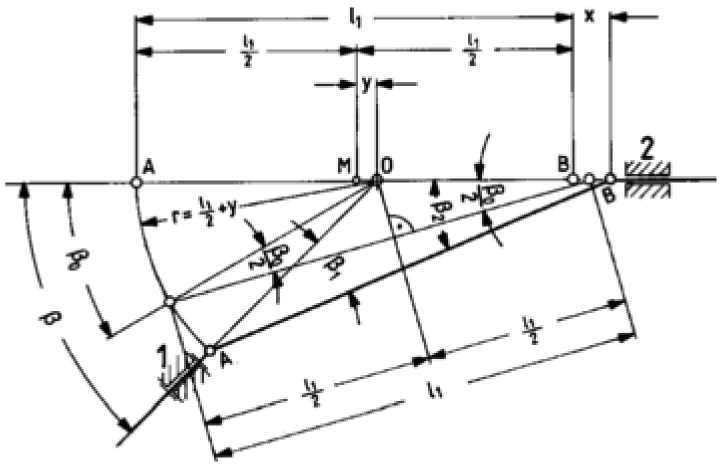
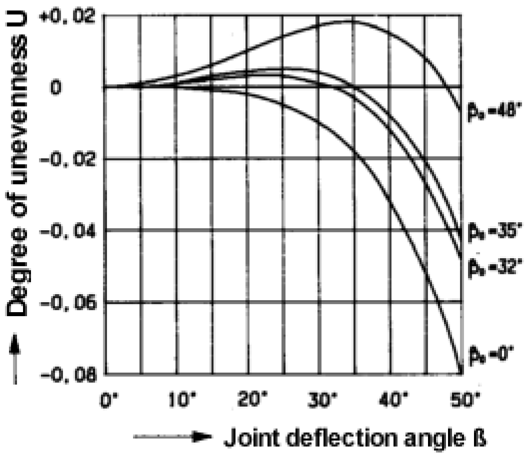


Fig. 28:

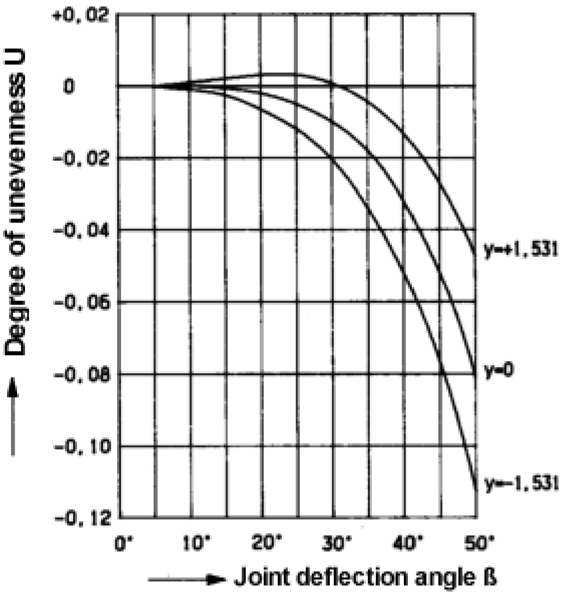


Now by offsetting the centre M of the extended joint by a dimension y in the direction of the fixed bearing, a specific deflection angle can be made to give constant velocity (Fig. 28). A constant velocity angle $ß_0$ of 32°-35° is favourable, as this gives the minimum unevenness the entire deflection angle range (Fig. 29).

Fig. 29:



Influence of constant velocity angle ßo
on degree of unevenness U



Influence of joint offset y
on degree of unevenness U

The offset y to be applied in order to achieve totally constant velocity at deflection angle $ß_0$ is:

$$y = \frac{l_1}{2}\left(\frac{1}{\cos\frac{\beta_0}{2}} - 1\right)$$

When the joint is deflected, an axial displacement of the drive shaft 2 occurs, so this must therefore have mobile bearings. The maximum axial displacement is:

$$x = l_1\left(\frac{\sin\left(90 + \frac{\beta}{2} - \arcsin\frac{\sin\beta}{2\cdot\cos\frac{\beta o}{2}}\right)}{\cos\frac{\beta}{2}} - 1\right)$$

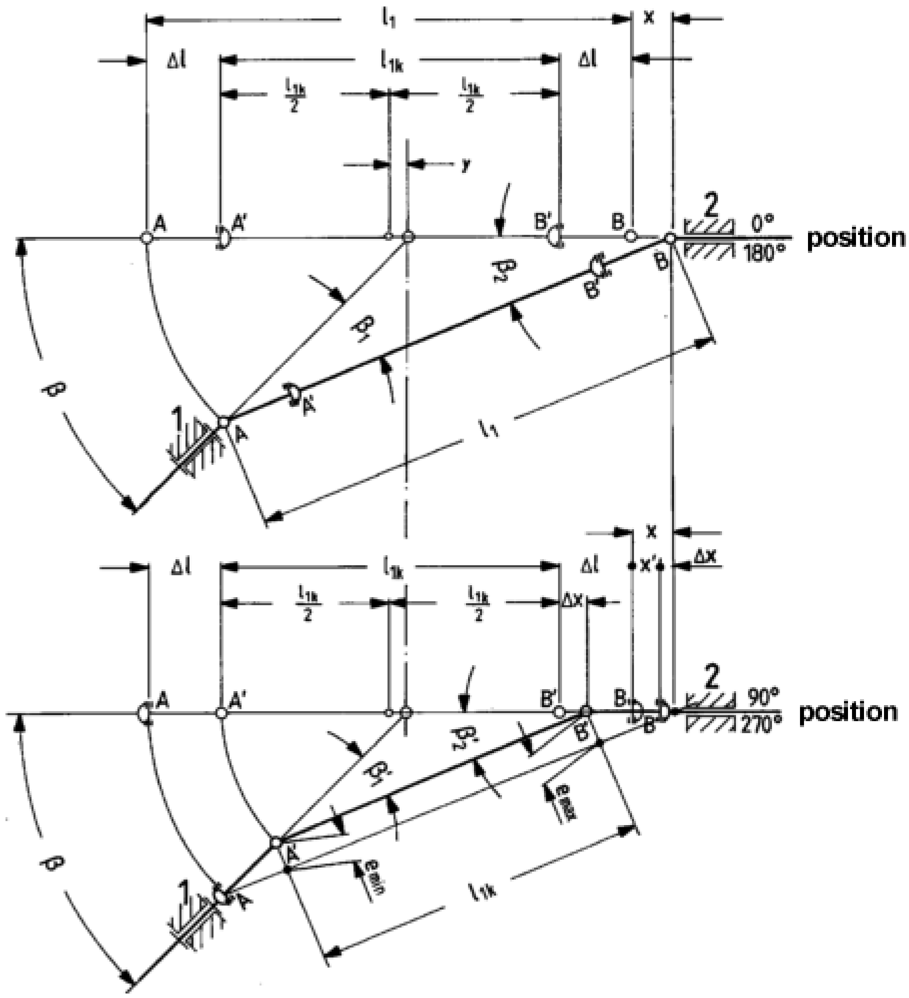
With a constant velocity angle of 32°:
$y_{32°} = 0,02 \cdot l_1$
and
$x_{40°} = 0,0641 \cdot l_1$ at 40° deflection angle,
$x_{48°} = 0,0944 \cdot l_1$ at 48° deflection angle.

9.2 Axial Movement of the Drive Shafts with the Use of Offset Axis Universal Joints

This catalogue shows only double jointed shafts with offset angle universal joints. In the bent state, in addition to the movements described under 9.1, these also generate an axial movement which is performed twice every shaft rotation (Fig. 30).

In the 0° and180° positions of the double joint, the axis offsets Δl (AA' and BB') are added linearly to the joint spacing l_{1k} (A'B').

Fig. 30:



In the 90° and 270° position of the double joint, the axis offsets Δl are added to the joint spacing l_{1k} according to the directions of the individual deflection angles $ß_1'$ and $ß_2'$.

The difference ΔX of these sums is the movement described by the drive shaft of the double jointed shaft twice per rotation. This must be taken into account in the dimensions.

Movement travel $\Delta X = X - X'$

X is the displacement of the double joint in the 0° and 180° position as produced also in the double shaft without offset axis joints.

X' is the displacement produced when on deflection of the joint in the 180° and 270° position of the double jointed shaft with offset joints, due to the shorter joint interval.

$$X' = l_{1k} \cdot \left(\frac{\left(\sin\ 90 + \frac{\beta}{2} - \arcsin\left(\left(\frac{1}{2} + \frac{l_1}{l_{1k}} \cdot \frac{1}{2} \cdot \left(\frac{1}{\cos\frac{\beta_0}{2}} - 1\right)\right) \cdot \sin\beta\right)\right)}{\cos\frac{\beta}{2}} - 1 \right)$$

With a constant velocity angle of 32°, assuming that $\Delta l = 0{,}1 \cdot l_1$ and thus:

$l_{1k} = l_1 - 2 \cdot \Delta L$
then

$X'_{40^\circ} = 0{,}0756 \cdot l_{1k}$

Thus for movement travel ΔX:

$\Delta X_{40^\circ} = 0{,}0641 \cdot l_1 - 0{,}0513 \cdot l_{1k}$
$\Delta X_{48^\circ} = 0{,}0944 \cdot l_1 - 0{,}0756 \cdot l_{1k}$

The axial movement of the drive shafts takes place in the area of the axial movement of the deflection, i.e. the cardan shaft is "shortened" twice per rotation.

9.3 Centre Displacement of Fork Head (Carrier Ring) with Deflected Joint

When designing the space required for the yoke, it must be noted that, in addition to the deflection and axial movement, its centre is displaced twice per rotation. The centre displacement e is greater on the drive shaft side than on the driven shaft side.

For the drive shaft side:

$e_{max} = (\Delta l + \Delta X) \cdot \sin ß_2'$

where the input drive deflection angle $ß_2'$ is calculated as follows:

$$\beta_2' = \arc\sin \left(\left(\frac{1}{2} + \frac{l_1}{l_{1k}} \cdot \frac{1}{2} \cdot \left(\frac{1}{\cos\frac{\beta_1}{2}} - 1 \right) \right) \cdot \sin\beta \right)$$

For the drive shaft side:

$e_{min} = \Delta l \cdot \sin ß_1'$

where the drive deflection angel $ß_1'$ is the difference between the total deflection angle $ß$ and the input drive deflection angle $ß_2'$.

So $ß_1' = ß - ß_2'$