When the tractor vehicle and the semitrailer are coupled, it is desirable to know the angular position of the trailer relative to the tractor vehicle as precisely as possible and to communicate it to a control device of the tractor vehicle and/or the semitrailer. This information is relevant, for example, for steerable axles of the trailer or for optimizing driver-assistance systems, both when reversing and driving forward. There are numerous approaches for determining the so-called articulation angle between tractor vehicle and semitrailer. Reference is made by way of example to EP 3 162 665 A1, DE 20 2012 008 717 U1, DE 199 64 059 A1, US 5,152,544 A, WO 2020/248 035 A1, AT 514 448 A1, US 2013/082 453 A1, US 2015/084 311 A1, GB 2 470 610 A, DE 10 2018 123 642 A1. In most known systems, a magnet and a magnetic-field sensor are used. The sensor is usually attached indirectly or directly to the fifth-wheel plate and the magnet to the kingpin. A disadvantage of this assembly is that the measurement result may depend not only on the articulation angle but also on a misalignment between the sensor and the magnet after coupling and on play between the kingpin and the fifth-wheel plate in the coupled state, and these two influencing factors may therefore result in the output of erroneous angle values.

It is therefore an object of the invention to provide a kingpin assembly that creates the preconditions for simple and accurate determination of the articulation angle. The object is achieved by a kingpin assembly according to claim 1.

According to the invention, on the one hand on the kingpin or the stationary bearing ring or the stationary bearing-ring segment and, on the other hand, on the rotatable bearing ring or the rotatable bearing-ring segment or on the driver, respectively, one element of a pair consisting of an angle sensor and an angle encoder is arranged.

This solution differs from all known solutions in that both the angle sensor and the angle encoder are assigned to the kingpin assembly and thus to the semitrailer. As a result, the relative position of the angle sensor and the angle encoder is always the same apart from the articulation angle to be detected, regardless of the condition of the fifth-wheel plate and its spatial position relative to the kingpin after coupling the tractor vehicle to the semitrailer. The arrangement furthermore has the considerable advantage that it can be retrofitted very easily, since a modification is required only on the semitrailer. In this case, elements (stationary and rotatable bearing ring or bearing-ring segment) of the existing rotary bearing around the kingpin are used to ensure a defined rotational movement of the angle sensor and the angle encoder relative to each other.

It should be noted that for the rotary bearing, stationary bearing rings and rotatable bearing rings having a 360° extent may be used, as well as only respective “bearing-ring segments”, or a combination of a bearing ring on the one hand and a “bearing-ring segment” on the other hand. To ensure the degree of freedom of the rotary motion and positional definition in all other dimensions,

Figure 9 shows the kingpin assembly from below with support frame;

Figure 10 shows the kingpin assembly in an exploded view; and

Figure 11 shows a schematic view of one embodiment of the kingpin assembly according to the invention in side view.

Figures 1 and 2 and 8 to 10 show the same kingpin assembly 1 for a semitrailer of an articulated vehicle, comprising a kingpin 2 defining an axis of rotation A, a rotary bearing 3 arranged about the axis of rotation A, and a support frame 4 connected to the rotary bearing 3 and pivotable about the axis of rotation A. In this multi-part embodiment, the support frame 4 has a mounting base with a cylindrical wall segment 16 and two fork-shaped holding arms 21 projecting essentially radially from the cylindrical wall segment 16.

On its upper side, the support frame 4 has a protective cover 22. Under the protective cover 22, at the free end 23 of the support frame 4 and attached thereto indirectly via a base plate, there is arranged within the support frame a connecting means, as a rule in the form of a plug (not shown). The support frame 4 is formed in sections as a V-shaped frame structure whose sides are adapted to the angle of the correspondingly configured entry opening.

The kingpin 2 has a kingpin flange 6 for mounting the kingpin 2 on the semitrailer and, more precisely here, on a disc 18 welded to the semitrailer plate 24. Mounting is performed, as is known in the prior art, by means of bolts 25 arranged along the flange 6 in a circular pattern. The disc 18 has an upward recess 26 in which the kingpin flange 6 and parts of the rotary bearing 3 are received. The depth of the recess 26 plus the thickness of the semitrailer plate 24 are dimensioned such that the rotary bearing 3, with the exception of the integrally formed cylindrical wall segment 16 of the support frame 4, does not project beyond the underside of the semitrailer plate 24.

Apart from this, the kingpin comprises, in a manner known per se, viewed from top to bottom, an upper collar 27, a necked portion 28 and a lower collar 29. The upper collar 27, the necked portion 28 and the lower collar 29 all have a circular-cylindrical basic form. At the upper collar, the kingpin has a radius r. The necked portion 28 is the section at which the lock of the fifth-wheel coupling engages.

The rotary bearing 3 comprises a bearing ring 7 stationary relative to the kingpin 2 and a bearing ring 8 rotatable relative thereto. The stationary bearing ring 7 is fastened directly to the kingpin flange by bolts 30. By screwing the flange 6 to the welded-in disc 18 and by screwing the stationary

bearing ring 7 to the flange 6, the kingpin assembly 1 as a whole or even only parts of the rotary bearing 3 can be replaced in a simple manner. In particular when retrofitting, no structural changes have to be made to the semitrailer because the kingpin assembly 1 according to the invention can simply be mounted in place of an old one. This is ensured not only by the identical bolted connection but also by the small installation space required for the rotary bearing 3 together with the support frame 4. For this purpose, it is again advantageous if, as can be seen in particular in Figures 1 and 4, the stationary bearing ring 7 is arranged radially inside with respect to the axis of rotation A and the rotatable bearing ring 8 is arranged radially outside.

The rotatable bearing ring 8 together with the stationary bearing ring 7 forms an axial-radial rotary bearing. In the axial direction, the bearing is provided by the mutually superposed axial sliding surfaces of the bearing rings 7 and 8. The sliding surfaces define the “plane of rotation” or “plane of the rotary bearing” 32; see Figure 4. In the radial direction, the bearing rings bear against one another along circular-cylindrical surfaces 34 and thus restrict the degree of freedom of movement of the support frame 4 to pure rotation. Along its outer circumferential surface, the rotatable bearing ring 8 has a circumferentially recessed stiffening rim 36.

The support frame 4 is fixed to the rotatable bearing ring 8. In the exemplary embodiment shown, it is integrally formed thereon with its cylindrical wall segment 16. The cylindrical wall segment thus forms the vertical connection from the plane 32 of the axial rotary bearing to the support frame 4. The position of the support frame 4 is thus determined by the rotary bearing 3 radially and axially relative to the kingpin 2 and semitrailer plate 24.

So that the support frame 4 does not tilt downward, or tilts as little as possible, due to its radial overall length, the kingpin assembly 1 has a support element 9. This is connected to the support frame 4 by means of a connecting element 12 that is length-adjustable in the radial direction R with respect to the axis of rotation A. It is arranged axially spaced below the plane 32 of the rotary bearing 3 and there bears directly against a circumferential or cylindrical lateral surface 11 of the upper collar 27 of the kingpin 2 arranged coaxially about the axis of rotation A. While the necked portion 28 must remain completely free for locking with the fifth-wheel coupling, in an alternative embodiment the support element 9 can also brace itself against the lower collar 29, which results in an overall larger lever and thus a firmer support.

In this example, the connecting element 12 is embodied as a threaded rod 13 which, on the radially outer side, is screwed into the cylindrical wall segment 16, which here forms the cross strut 14, and in this way is supported thereon. Alternatively, it can also be fixed thereto, for example, by a material bond or a frictional connection. On the other side, the threaded rod 12 is screwed into a metal block 40 of the support element 9 and locked with a nut 42. As part of the support element 9, the