When the tractor vehicle and semi-trailer are coupled, it is desirable to know the angular position of the semi-trailer relative to the tractor vehicle as accurately as possible and to communicate this to a control device on the tractor vehicle and/or semi-trailer. This information is relevant, for example, for steerable axles on the semi-trailer or for optimizing driver assistance systems, both when reversing and driving forward. There are numerous approaches to determining the so-called articulation angle between the tractor vehicle and the semi-trailer. Reference is made, for example, to documents CN 1 12 298 383 A, EP 3 162 665 A1, EP 3 210 857 B1, DE 20 2012 008 717 U1, DE 199 64 059 A1, US 5 152 544 A, WO 2020/248 035 A1, US 2013 /082 453 A1, US 2015 /084 311 A1, GB 2 470 610 A, DE 10 2018 123 642 A1. Most known systems use a magnet and a magnetic field sensor. The sensor is usually attached directly or indirectly to the fifth wheel coupling plate and the magnet to the kingpin. A disadvantage of this arrangement is that the measurement result depends 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 coupling plate when coupled, and these two influencing factors therefore result in the output of incorrect angle values.

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

According to one example, the kingpin assembly has an angle measuring device that is at least partially recessed into the kingpin, with a shaft that can rotate around the axis of rotation and a driver that is rotationally fixed to the shaft so it can rotate and pivot around the axis of rotation (A).

In contrast to an angle sensor with an external angle encoder, an angle measuring device is understood to be a unit integrated in a housing and consisting of an angle encoder and an angle sensor matched to it and rotatable relative to the angle encoder about the axis of rotation, wherein, for the purpose of transmitting a rotary movement, the shaft is connected in a rotationally fixed manner to either the angle encoder or the angle sensor and is rotatably mounted in the housing. The counterpart of the unit, i.e. the angle sensor or the angle encoder, is in turn connected to the housing in a rotationally fixed manner so that either the shaft together with the angle encoder can rotate relative to the angle sensor and the housing or, conversely, the shaft together with the angle sensor can rotate relative to the angle encoder and the housing. Consequently, the driver drives the angle encoder or the angle sensor via the shaft and the counterpart is held connected to the kingpin in a rotationally fixed manner via the housing.

The arrangement 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 semi-trailer. The relative position of the angle sensor and angle encoder is therefore always the same, apart from the articulation angle to be detected, regardless of the condition of the fifth wheel coupling plate and its spatial position relative to the kingpin after the tractor vehicle has been coupled to the semi-trailer. The solution according to the invention also has the considerable advantage that it can be retrofitted very easily, since only the semi-trailer needs to be modified.

A driver is understood here to be a means which is connected on one side to the shaft of the angle measuring device in rotationally fixed manner and is designed on the other side to be supported directly or indirectly on a component of the tractor vehicle, such as the fifth wheel coupling plate, its bearing blocks, its support frame or a connecting unit (plug socket) or its support, thereby transmitting a relative rotation of this component about the axis of rotation to the shaft. The driver is designed, for example, to interact with the fifth wheel coupling plate in the coupled state in such a way that the relative rotation between the kingpin and the fifth wheel coupling plate is transmitted to the shaft with as little play as possible. For this purpose, indirect or direct positive contact between the driver and the fifth wheel coupling plate or an element fixed to it may be considered.

The driver preferably comprises a centering element which is designed to center the driver in relation to the entry opening of a fifth wheel coupling plate of a tractor vehicle.

In this design, the centering element therefore serves to support itself on the fifth wheel coupling plate and thereby transmit a relative rotation thereof about the axis of rotation of the kingpin to the shaft.

The shaft is preferably led out on a bottom side of the kingpin facing away from the kingpin flange and connected to the driver.

The shaft is referred to as "led out" if it protrudes from the bottom side of the housing of the angle measuring device and/or the kingpin in such a way that radial access to the shaft is possible, for example to connect the driver radially to the shaft.

Preferably, the kingpin protrudes on the bottom side with at least one projection in the axial direction downwards beyond the driver and the shaft.

The projection serves to protect the shaft and the driver, in particular when the kingpin is moved into and out of the entry opening of the fifth wheel coupling plate, against collision with components of the tractor vehicle, in particular the fifth wheel coupling plate, its bearing blocks or substructure.

In a first alternative design, the angle measuring device is preferably recessed into the kingpin on the upper side attributed to the kingpin flange, and the shaft is rotatably mounted or received in a bore that axially penetrates the kingpin.

This design has the advantage that the angle measuring device is enclosed between the king pin and the weld-in plate and is therefore very well protected against mechanical damage. Damage to the device during coupling is virtually impossible. Furthermore, the shaft is guided over a greater length in the king pin so that any radially acting loads are not or only to a small extent transmitted to the bearing of the shaft in the angle measuring device.

It is particularly preferred that the angle measuring device is recessed into the king pin on the upper side to such an extent that the angle measuring device has a distance $d > 1$ mm, preferably > 2 mm, to the bottom of the weld-in plate when the kingpin is connected to the weld-in plate, and it is particularly preferred that the angle measuring device is recessed flush with the upper side in the kingpin.

This ensures that the angle measuring device fits completely into the installation space between the kingpin and the weld-in plate and is protected from damage before and during installation.

In a second alternative design, the angle measuring device is preferably recessed into the kingpin on the bottom side facing away from the kingpin flange.

This design has the advantage that the hole penetrating the kingpin axially can be dispensed with. Furthermore, the angle measuring device is easily accessible from the outside on this side, so that the kingpin does not have to be removed first for replacement or repair. Finally, the cable routing to the angle measuring device is also simplified.

Preferably, the kingpin assembly has a pivot bearing arranged around the axis of rotation, which has a bearing ring stationary relative to the kingpin or a stationary bearing ring segment and a bearing ring rotatable relative thereto or a rotatable bearing ring segment, wherein the driver is fixed in a rotationally fixed manner directly or indirectly to the rotatable bearing ring or rotatable bearing ring segment.

Such a rotary bearing is already known, for example, from the aforementioned publications DE 20 2022 106 659 U, EP 3 891 051 A1, EP 1 918 179 A1, and DE10 2004 024 333 A1. It is possible to use this rotary bearing to guide the driver, which is otherwise only connected to the shaft of the angle measuring device, thereby relieving the bearing of the shaft in the housing of the angle measuring device when radial loads occur and ensuring a defined

In this embodiment, the driver 18 is fixed to the support frame 26 and, more precisely, to the cylinder wall segment 27. Since the cylinder wall segment 27 is integrally formed on the rotatable bearing ring 32, the driver 18 is thus also fixed directly to the rotatable bearing ring 32. In this way, the driver 18 is held at its end facing away from the shaft 17 and guided in a precise circular path around the axis of rotation A. This supports the radial bearing of the shaft 17 in the angle measuring device 15 and in the bore of the kingpin 2.

In this example, the angle measurement signal from the angle measuring device 15 is routed via the signal line 20 from the end of the driver 18 in a radial direction to the plug (not shown) and can be transferred via this to a coupled tractor vehicle. However, the signal line 20 can also or additionally lead directly within the semi-trailer to a processor which processes the signal, for example for the purpose of controlling steerable axles or driving assistance systems.

The kingpin assembly 1" of the embodiment shown in Figure 3 has essentially the same structural design as that of the embodiment shown in Figure 2. The differences lie in the positioning of the angle measuring device 15, which is recessed into the kingpin 2 on the bottom side 19 facing away from the kingpin flange. As a result, the axial bore through the kingpin is omitted and the shaft 17 is significantly shorter. Otherwise, the driver 18 is also connected to the shaft 17 and runs in the same way as in the embodiment shown in Figure 2 until its end fixed to the cylinder wall segment 27. In this arrangement, the guidance of the driver 18 at its end facing away from the shaft 17 is even more important because the comparatively short shaft 17 is only mounted or supported in the angle measuring device 15 and no longer additionally in a bore in the king pin 2. The signal line 20 runs completely outside the shaft 17 and along the driver 18.