A drive unit for driving at least one wheel drive shaft, in particular a wheelset axle, in particular a cross-drive for use in rail vehicles with a driving engine and a transmission assembly coupled thereto. The output of the transmission assembly is formed by a hollow shaft which is coupled via an articulated coupling to the wheel drive shaft, in particular the wheelset axle. A first braking subsystem and a second braking subsystem are embodied as disk brake systems, each comprising at least one brake disk. An attachment flange of the brake disk of one braking subsystem is embodied in integral fashion with the hollow shaft. Placement of the braking subsystems along the hollow shaft is disclosed.
DRIVE UNIT FOR A RAIL VEHICLE WHEEL SET

BACKGROUND OF THE INVENTION

[0001] The invention relates to a drive unit for driving at least one wheel drive shaft, in particular of a wheelset axle, for rail vehicles.

[0002] Such a drive unit has been disclosed by DE 4 137 233 A.

[0003] The solution described there has, however, the disadvantage that the necessary installation space is relatively large, which has disadvantageous effects particularly in vehicles of the low-platform type. The fabrication and mounting are also relatively complex.

[0004] A similar design of a drive unit has been disclosed by U.S. Pat. No. 4,042,071, see column 1, lines 12-14 in this document.

[0005] Drive units for rail vehicles, in particular having an integrated cross-drive, are known in a multiplicity of embodiments. These comprise a driving engine which is coupled to a transmission assembly. The drive of the transmission assembly is formed by a hollow shaft which is coupled via an articulated coupling to the wheel drive shaft, in particular the wheelset axle, in order to compensate the relative movements between the wheelset axle and cross-drive. The driving engine is arranged here in the direct spatial vicinity of the transmission assembly, preferably both—driving engine and transmission assembly—are connected to one another by flanges in the region of their housings. As a result of this measure, only one radial bearing is necessary for the driving engine and a corresponding end shield. The coupling of the drive shaft of the driving engine to the transmission input shaft is carried out by means of what is referred to as a rotationally rigid and radially rigid diaphragm coupling. The transmission assembly itself is usually embodied in two stages or in a single stage with an intermediate wheel. The output gearwheel is seated here on the hollow shaft, said output gearwheel being either coupled fixed in terms of rotation to the hollow shaft or else forming one physical unit with said hollow shaft. The physical unit composed of the driving engine and transmission assembly, which is also referred to as an integrated cross-drive, is attached only at three points in the bogey frame with primary suspension. If necessary, a braking system is assigned to the drive unit, the brake disk being arranged on the hollow shaft. The activation elements are arranged in the housing of the transmission assembly. The disadvantage of the previous solution is that, on the one hand, the overall costs for the structural implementation and fabrication are relatively high. Furthermore, in particular for embodiments which are to be used in low-platform vehicles, the available radial and axial installation space is considerably reduced as a result of wheel diameters which are becoming ever smaller while at the same time drive hollow shaft internal diameters are becoming larger owing to the softer suspensions. There is thus no longer sufficient installation space available to arrange the braking system in this region in order to achieve sufficient braking deceleration. Solutions for this are to arrange the braking system at another location or else to do without conventional mechanical braking systems and use other braking systems, for example electrical braking systems, which are however more costly.

SUMMARY OF THE INVENTION

[0006] The invention has therefore been based on the object of developing a drive unit for a wheel drive shaft, in particular a wheelset axle, in particular for the use of rail vehicles of the type mentioned at the beginning, in such a way that sufficient braking deceleration is achieved with simple means and also with an axial and radial installation space which is becoming smaller and smaller. The structural solution is intended here to be defined by a simple embodiment, cost-effective fabrication and mounting. Furthermore, the solution according to the invention is to be applicable in particular for vehicles of the low-platform type.

[0007] According to the invention, the drive unit for driving at least one wheel drive shaft, in particular of a wheelset axle, comprises a cross-drive with a driving engine and a transmission assembly which is coupled thereto. The output of the transmission assembly is embodied as a hollow shaft and is connected to the wheel drive shaft or the wheelset axle via a coupling, in particular an articulated coupling. The braking system comprises two braking subsystems by means of which the entirety of the braking force necessary can be generated by activating two braking subsystems.

[0008] The solution according to the invention provides the advantage that as a result of the distribution between a plurality of braking systems said braking systems can, in their entirety, be kept respectively smaller in terms of their dimensions in the radial and axial directions and the installation space available can thus be used to an optimum degree.

[0009] There are a multiplicity of ways in which the individual braking subsystems can be arranged. They can either be arranged on the two sides of the transmission assembly, one of the two braking subsystems being arranged between the transmission assembly and the first coupling element of the coupling which is necessary for coupling to the wheelset axle. In order to provide the necessary braking force while taking into account the necessary installation space for the individual braking subsystems, additional attachment means, which take up space, for the elements to be connected to one another have been dispensed with and the entire system has been structurally simplified. Here, the hollow shaft is embodied integrally with at least one of the attachment flanges for one of the braking subsystems. In a further advantageous refinement, the first coupling part of the articulated coupling is also embodied in one piece with the hollow shaft. As a result, the radial installation space necessary for the connecting elements is significantly reduced in comparison with that in embodiments according to the prior art. The solution according to the invention provides the advantage that the available radial and axial installation space resulting from the wheel diameters which are becoming smaller and smaller while at the same time the output hollow shaft internal diameters are becoming larger and larger owing to the softer suspensions is utilized to an optimum degree and at the same makes available the necessary braking deceleration.

[0010] There are also a multiplicity of possible ways of arranging the hollow shaft and an attachment flange of a braking subsystem and/or of the first coupling element of the articulated coupling in an integrated fashion. Here, the embodiment can be effected in an integral fashion as a cast...
part or forged part. However, the specific selection depends on the requirements of use and is at the discretion of the person skilled in the related art.

[0011] According to a further aspect of the invention, it is also possible to arrange both braking subsystems between the transmission assembly and articulated coupling. In this case, both attachment flanges form one physical unit with the hollow shaft.

[0012] In one development there is provision for the transmission housing to be embodied in an integral fashion. The hollow shaft is supported by means of a bearing arrangement in the housing of the transmission assembly. For the sake of simplification and standardization there is provision for the external diameter of the bearings to be identical for all embodiment variants, while adjustment is carried out to the requirements of use by means of variable bearing arrangement internal diameters and thus hollow shaft external diameters.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The solution according to the invention is explained below with reference to Figures.

[0014] FIG. 1 shows an axial section of a schematic simplified view of the basic design of a drive unit designed according to the invention;

[0015] FIGS. 2a and 2b show the coupling of the attachment flanges of the individual braking subsystems to the hollow shaft.

DESCRIPTION OF A PREFERRED EMBODIMENT

[0016] FIG. 1 shows a schematic simplified view of the basic design of a drive unit designed according to the invention for driving at least one wheel drive shaft which is coupled to at least one wheel and which is formed by a wheelset axle 3 in the case illustrated. The drive unit 1 comprises an integrated cross-drive 4. This comprises a driving engine 5 which is coupled to the transmission assembly 6. For this purpose, the drive shaft 7 of the driving engine 5 is connected fixed in terms of rotation to an input 8 of the transmission assembly 6, preferably via a coupling element 9 in the form of a diaphragm coupling which is rotationally rigid and embodied so as to be rigid in the radial direction. The transmission assembly 6 comprises an output 10 which is formed by a hollow shaft 11 which encloses the wheelset axle 3 in the circumferential direction and over at least part of its axial extent. Said hollow shaft 11 is connected to the wheelset axle 3 via an articulated coupling 12. The articulated coupling 12 comprises here a first coupling part 13 and a second coupling part 14 which can be connected to one another in a rotationally elastic fashion. The first coupling part 13 is connected here fixed in terms of rotation to the hollow shaft 11. The second coupling part 14 is coupled at least indirectly fixed in terms of rotation to the wheelset axle 3. Here, at least indirectly means that the connection is made directly to the wheelset axle or else via further transmission elements, for example a second coupling level. In one advantageous refinement, the hollow shaft 11 and the first coupling part 13 are of integral design. Furthermore, the drive unit 1 comprises a braking system 15 which is preferably embodied in the form of a disk brake unit 16.

[0017] According to the invention, the braking system 15 comprises at least two braking subsystems 17.1 and 17.2 which are each embodied as disk brake systems. The necessary overall braking force is thus generated by two braking subsystems 17.1 and 17.2. These comprise in the exemplary embodiment shown, respective brake disks 18.1 and 18.2 which are attachable to the hollow shaft 11 by respective attachment flanges 19.1 and 19.2 which form one physical unit with the hollow shaft 11. At least one flange for example, attachment flange 19.2 arranged between the transmission assembly 6 and articulated coupling 12, is preferably formed with the hollow shaft 11 from one component. The second attachment flange 19.1 may be attached to the hollow shaft 11 by means of attachment elements. The two attachment flanges 19.1 and 19.2 are arranged here on both sides of the transmission assembly 6. The activation elements (not illustrated here) can thus easily be arranged and attached to the housing 20 of the transmission assembly. The indicated arrangement of 19.1 and 19.2 for the braking subsystems 17.1 and 17.2 and the absence of the crown gear known from the prior art between the hollow shaft 11 and the first coupling part 13 provides, in addition to more cost-effective fabrication, the advantage of requiring less radial installation space. By dispensing with the crown gear between the hollow shaft 11 and the first coupling part 13, less installation space is required in the radial direction for the coupling between the hollow shaft 11 and first coupling part 13. Furthermore, the reduced radial and axial installation space required due to distribution of the braking force between two braking systems, allows the hollow shaft internal diameter $D_{11}$ to be increased to an optimum degree.

[0018] The driving engine 5 and the transmission assembly 6 are arranged spatially near to one another, preferably connected to one another by flanges in the region of their housings 21 and 20. There are also a multiplicity of possible designs of the transmission assembly 6. In the simplest case it comprises two pairs of spur wheels, a first set of spur wheels 22 and a second set of spur wheels 23. The first set of spur wheels 22 comprises a spur wheel 24 which is coupled fixed in terms of rotation to the transmission input shaft 8, the spur wheel 24 either forming one integral assembly with the transmission input shaft 8 or else being connected fixed in terms of rotation to it. The spur wheel 24 intermeshes with a spur wheel 26 which is arranged on an intermediate shaft 25. Furthermore, a second spur wheel 27 is arranged on the intermediate shaft 25, said second spur wheel 27 being a component of the second set of spur wheels 23 and intermeshing with a spur wheel 28 which is connected fixed in terms of rotation to the hollow shaft 11. In one particularly advantageous embodiment, the hollow shaft 11 and spur wheel 28 are embodied as an integral component. In terms of fabrication, the integral component composed of the hollow shaft 11, the attachment flange 19.2 and the first coupling part 13, and optionally also the spur wheel 28, can be embodied as a cast part or forged part. As a result, the external diameter of the articulated coupling 12, $D_{12}$ and that of the brake disks, $D_{18.1}$ and $D_{18.2}$ can be minimized, while simultaneously the internal diameter $D_{11}$ of hollow shaft 11 can be maximized.

[0019] According to a further aspect of the invention, the housing 20 of the transmission assembly 6 is embodied in an integral fashion, i.e., as a one-piece structure, whereby the bearing arrangement 29 of the hollow shaft 11 in the housing 20 provides for a fine gradation of the internal diameter $D_{20}$
while simultaneously keeping the roller bearing external diameter $D_{A20}$ constant. This measure provides a very small transmission center, i.e. transmission assembly 6 with a simultaneously high roller bearing service life.

[0020] The inventive solution of the embodiment of the hollow shaft 11, attachment flange 19.2 and of the first coupling part 13 as one integral component can be used for a multiplicity of integrated cross-drives 4 and is not tied to a specific embodiment of the transmission assembly 6 or of the driving engine 5. Other embodiments which lie within the field of activity of a person skilled in the respective art are also conceivable.

[0021] According to FIG. 2a, the attachment flange 19.2 of the second braking system 17.2 is embodied in an integral fashion with the hollow shaft 11. The attachment flange 19.1 of the first braking system 17.1 is connected, as a separate component, fixed in terms of rotation to the hollow shaft 11 by means of attachment elements 30, for example in the form of screw elements which are arranged at specific intervals in the circumferential direction of the attachment flange 19.1. A structural embodiment of the connection of the brake disk of the second braking system 17.2 to the attachment flange 19.2 is illustrated in FIG. 2a. FIG. 2b shows a possible structural embodiment of the connection of the brake disk 18.1 to the attachment flange 19.1 of the first braking subsystem 17.1, and the attachment of the attachment flange 19.1 to the hollow shaft 11.

1. A drive unit for a rail vehicle wheel set, the drive unit comprising:

a transmission assembly including a coupling for connection to a driving engine, and a hollow rotatable transmission output shaft;

an articulated coupling which connects the hollow shaft with a wheel drive shaft which carries wheels for the vehicle for rotation together, whereby driving torque is coupled directly to the wheel drive shaft;

a braking system comprising first and second braking subsystems operable on the hollow shaft and spaced apart from each other along the hollow shaft;

the first braking subsystem including an attachment flange attached to the hollow shaft, and brake elements for braking on the attachment flange;

a bearing arrangement for the hollow shaft supporting the hollow shaft for rotation, the bearing arrangement being disposed in the transmission assembly.

2. The drive unit of claim 1, further comprising a driving engine, and the transmission assembly being coupled to the driving engine for operating the transmission assembly to rotate the hollow shaft.

3. The drive unit of claim 2, wherein the transmission assembly includes a housing around the transmission assembly and the bearing arrangement for the hollow shaft being within the housing of the transmission assembly.

4. The drive unit of claim 1, wherein each of the first and second braking subsystems comprises disk brake systems, each comprising at least one brake disk which cooperates with the hollow shaft for braking rotation of the hollow shaft.

5. The drive unit of claim 4, wherein the attachment flange of the first braking subsystem cooperates with the brake disk thereof.

6. The drive unit of claim 5, wherein the second braking subsystem has an attachment flange which is a component separate from the hollow shaft and a device for attaching the second attachment flange to the hollow shaft for rotating therewith.

7. The drive unit of claim 6, wherein the hollow shaft and the attachment flange of the first braking subsystem are integrally embodied as a cast part.

8. The drive unit of claim 6, wherein the hollow shaft and the attachment flange of the first braking subsystem are integrally embodied as a forged part.

9. The drive unit of claim 5, wherein the attachment flange of the first braking subsystem and the hollow shaft are formed as one component.

10. The drive unit of claim 1, wherein the transmission assembly which is connected with the hollow shaft has first and second opposite sides spaced along the axis of the hollow shaft, and the first and second braking subsystems are respectively arranged toward the first and second axial sides of the transmission assembly;

the articulated coupling between the axle and the hollow shaft being so positioned with respect to the transmission assembly that the second braking subsystem is disposed between the transmission assembly and the articulated coupling along the axis of the hollow shaft.

11. The drive unit of claim 10, further comprising a housing around the transmission assembly connected with the hollow shaft;

an activation device for the first and second braking subsystems and the activation device is arranged on the housing of the transmission assembly.

12. The drive unit of claim 1, wherein the articulated coupling comprises a first coupling part coupled to the hollow shaft and the first coupling part is integrally embodied with the hollow shaft, the articulated coupling additionally being coupled to the wheel drive shaft.

13. The drive unit of claim 1, wherein both of the first and second braking subsystems are arranged between the transmission assembly and the articulated coupling.

14. The drive unit of claim 13, wherein each of the first and second braking systems has a respective attachment flange which is integral with the hollow shaft and respective brake elements for braking on the attachment flanges.

15. The drive unit of claim 1, wherein the bearing arrangement has a fixed external diameter and is adapted to accommodate hollow shafts having different external diameters.

16. The drive unit of claim 1, wherein the transmission includes a housing formed as an integral unit.

17. A drive unit for a rail vehicle comprising:

a driving unit having an output shaft;

a wheel set including two wheels connected to an axle to be driven thereby;

wherein the driving unit output shaft and the axle extend parallel to each other;

a transmission assembly including a coupling for connection to the driving engine output shaft, and a hollow
rotatable transmission output shaft which extends parallel to the driving unit output shaft and the axle;
an articulated coupling which connects the hollow shaft with the wheel drive axle for rotation together;
a braking system comprising first and second braking subsystems operable on the hollow shaft and spaced apart from each other along the hollow shaft;
the first braking subsystem including an attachment flange attached to the hollow shaft, and brake elements for braking on the attachment flange; and
a bearing arrangement rotatably supporting the hollow shaft for rotation, the bearing arrangement being disposed within the transmission assembly.

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