

5 The invention relates to an electric drive, in particular for motor vehicles, comprising at least one electric motor having an inner cavity accommodating at least a substantial part of a planetary gear system connected to the rotor of the electric motor.

10 In electric drives a torque of the required quantity, as necessary for instance also for driving vehicle wheels, is often produced by a mechanical gear reduction in a gear system connected thereto. So far it has been usual in this respect to dispose the gear system axially beside the electric motor proper.

15 An electric drive of the above-indicated type is known from US-A-2 514 460. In this electric drive, both a first motor part, which is connected to the wheel to be driven and is equipped with coils, and a second motor part, which is disposed within said first motor part and serves as armature, are designed as rotating components. Between the
20 two motor parts there is provided a planetary gear system that is accommodated in the inner cavity.

25 US-A-4 274 023 discloses an electric drive having a planetary gear system, in which stator coils are disposed on the inner wall of a casing closed at the ends, with said stator coils being located opposite rotor coils of an internal rotor. Inside the rotor, there is provided a planetary gear arrangement.

30 It is the object of the invention to provide an electric drive of the type indicated, which can be built in particularly compact manner.

 This object is met by the invention indicated in claim 1. Preferred developments are indicated in the dependent claims.

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The expression "substantial part" used herein means that, in comparison with the conventional arrangement axially beside the electric motor, a considerable amount of space outside of the electric motor is saved. In many cases it is possible to accommodate the entire gear system or almost the entire gear system in the cavity. In other cases a gear stage can be accommodated in the cavity.

The planetary gear system contains at least one planet stage, however, gear systems with several planet stages that can be activated and deactivated selectively, e.g. gear systems of the type of the known automatic transmissions for motor vehicles and gear systems with an "overdrive" in the form of a planetary gear set, are possible as well.

The most favourable conditions for creating the inner cavity are offered by electric motors in which the so-called effective area, i.e. the usually cylindrical air gap portion between the rotor and the stator, has a large diameter. Such electric motors are not very widespread in practical application. In accordance with a construction that is particularly preferred in connection with the invention, the electric motor is of a construction in which the rotor is equipped with permanent magnets of alternating polarity and the stator is equipped with coils controlled electronically as regards switching thereof, or vice versa; the permanent magnet material may have an μ_r that is as low as possible, in particular in the range of $\mu_r = 1$ to 3. Particularly preferred are electric motors with an external rotor in synchronous construction. Electric motors of the above-described type can be built with effective areas of large diameter.

The invention and further developments of the invention will be elucidated in more detail hereinafter by way of a schematically illustrated embodiment.

5 Fig. 1 shows a sectional view of an electric drive, with the lower half, which is of analogous configuration, being omitted for reasons of clarity.

10 Fig. 1 shows a stationary cylindrical base member 4 of the electric drive 2, which has a leftwardly projecting hollow cylindrical extension 8. Attached to the outer circumference of extension 8 are cylindrical stator poles 12 constituting in conjunction with coils, not shown, the stator 10 of the electric motor 2. The rotor 12 of the electric motor 2 is open at one face side and is of substantially cylindrical pot-shaped configuration.
15 On the inner periphery of the circumferential wall of the rotor 12, there are attached permanent magnets 14 of alternating polarity in circumferentially distributed manner. The permanent magnets 14 are located opposite the stator 10 with a cylindrical air gap therebetween.

20 In the centre of the axial limiting wall of the rotor pot, a shaft 16 is mounted such that it projects axially into the inner cavity of the electric motor 2. This cavity is located inside the left-hand extension 8 of the base member 4 and also somewhat axially to the left thereof.

25 The shaft 16 rotating together with rotor 12 is provided in an axial portion with pinion teeth 18. The pinion teeth 18 mesh with a plurality of circumferentially distributed planet wheels 20. The planet wheels 20 are supported by means of bolts 22 in a planet carrier 24 which, at its left-hand axial end, is formed with a larger diameter and is fixedly
30 connected there to the left-hand face end of the extension 8 of the base member 4, such that the planet carrier 24 is stationary together with the base part 4. The planet carrier 24, with portions of its inner circumference, serves at the same time for supporting the shaft 16 and thus the entire rotor 12.

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Furthermore, there is provided a ring gear member 26 having, in the left-hand portion, a pot-shaped configuration with internal teeth 28 and, in the right-hand portion, being in the form of a shaft 30. The teeth 28 formed on the cylindrical inner circumference of the pot-shaped portion of the ring gear member 26 mesh with the planet wheels 20. The torque from the electric drive is fed axially outside towards the right via shaft 30. Shaft 30 is supported in the base member 4.

It can be seen that the entire planetary gear system 32 described is accommodated in the interior of the electric motor 15 and that support of the rotor 12 is effected by way of the support of gear shaft 16.

If necessary, the base member may be completed to form an entire casing around the rotor.



Patent Claims

- 5 1. An electric drive (2), in particular for motor vehicles, comprising at least one electric motor (15) having an inner cavity accommodating at least a substantial part of a planetary gear system (32) connected to the rotor (12) of the electric motor (15), characterized by the following features:
- 10 (a) the electric motor (15) comprises a base member (4) having said inner cavity and carrying the stator (10) of the electric motor (15) on its outer circumference;
- 15 (b) the planet carrier (24) of said planetary gear system (32) is mounted to the base member (4) of the electric motor (15) in stationary manner;
- 20 (c) the rotor (12) of the electric motor (15) is in the form of a pot-shaped external rotor and connected to a shaft (16) supported on the planet carrier (24) of said planetary gear system (32);
- (d) the planet wheels (20) of said planetary gear system (32) mesh internally with pinion teeth (18) associated with said shaft (16) and externally with the internal teeth (28) of a ring gear member (26) constituting the drive output side of the planetary gear system (32).
- 25 2. An electric drive according to claim 1, characterized in that the planetary gear system (32) is of multi-stage design, with at least one stage being accommodated in said cavity.
- 30 3. An electric drive according to claim 1 or 2, characterized in that the planetary gear system (32) comprises at least one activatable and deactivatable planet stage.
- 35 4. An electric drive according to any one of claims 1 to 3, characterized in that an electric motor (15) of such construction is provided in which the stator (10) is equipped with coils controlled electronically with respect to switching and, preferably, the rotor (12) is equipped with permanent magnets (14).