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Translator's Declaration

I, Nicholas Hartmann, translator, having an office at 8813 N. 85th Court, Scottsdale, Arizona, 85258, declare that I am well acquainted with the English and German languages and that to the best of my knowledge, the appended document is a complete and faithful translation of:

International patent application PCT/EP2003/007973, entitled

"Antriebsstrang eines Kraftfahrzeuges"

[Drive train of a motor vehicle]

All statements made herein are to my own knowledge true, and all statements made on information and belief are believed to be true; and further, these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the document.

Date: April 10, 2014

Nicholas Hartmann

DRIVE TRAIN OF A MOTOR VEHICLE

The invention relates to the drive train of a motor vehicle, in accordance with selected features of Claim 1.

Known drive trains of a motor vehicle possess a drive unit that is in driving connection with two vehicle wheels via a startup element, a transmission, an output shaft of the transmission, and a final drive. The drive train is a multidimensional oscillator or continuum oscillator that is excited to torsional vibrations as a consequence of fluctuating, nonlinear, or time-variable excitation resulting from the drive unit, from clutching conditions or shifting conditions, and from time-variable output drive conditions at the vehicle wheels. Further excitation mechanisms for torsional vibrations are the tooth sets of gear drive systems, a parameter excitation, and excitations as a result of the transfer behavior of universal joints in propeller shafts. In addition, when a hydrodynamic torque converter and a converter lockup clutch are used, further torsional vibrations of the drive train can occur upon actuation of the converter lockup clutch. Torsional vibrations of this kind have a disadvantageous effect on the dynamics of the motor vehicle, in particular with regard to noise characteristics and/or driving comfort characteristics.

In order to reduce such torsional vibrations, it is known to interpose spring-damper elements in the power path of the drive train. A two-mass flywheel is used, for example, in which the spring is arranged between a primary flywheel and a secondary flywheel (before a startup clutch in the power path). The inertial torque of the transmission parts is increased by the flywheels. The resonance region of the drive train is thus below the idle rotation speed of the drive unit, so that there is less transfer of rotation-speed fluctuations of the drive unit (see, for example, the documents listed in IPC class F16D003-14).

A further action for avoiding undesired torsional vibrations is the placement of a torsional damper in the region of the startup element. This is, for example, integrated into the entraining disc of a dry clutch, and/or associated on the input/output side with a hydrodynamic torque converter.

A further possibility for influencing torsional vibrations is represented by the use of a hydrodynamic torque converter that exhibits improved vibration behavior as a result of the hydrodynamic power transfer.

Also known is the use of a constantly or intermittently slipping wet or dry friction clutch in electronically controlled clutch systems. It is furthermore possible, when a hydrodynamic torque converter is used, to employ a controlled converter lockup clutch that likewise brings about an improvement in vibration behavior.

In particular in order to attenuate resonance phenomena, it is furthermore known to utilize a canceller in the region of the universal joint shaft (cf. DE 197 33 478 A1, DE 42 01 049, DE 199 14 871 A1, DE 196 04 160 C1, DE 42 38 683 C1). The use of a canceller in the region of a flywheel, of a two-mass flywheel, or of a clutch is known, for example, from the documents DE 100 37 680 A1, DE 199 51 577 A1, DE 197 09 092 C1, DE 197 09 092 C1, and DE 198 31 158 A1.

The underlying object of the present invention is to propose a drive train that is improved in terms of dynamic transfer behavior.

The object on which the invention is based is achieved by the features of Claim 1. The drive unit is in driving connection with one or more vehicle wheels via at least one startup element, in particular a clutch or a hydrodynamic torque converter; one or more (sub-)transmissions; at least one output shaft of the transmission which is connected, for example, to a propeller shaft; and one (or, in the case of all-wheel drive, two) final drives. The drive unit can be embodied as an internal combustion engine, hybrid drive, or starter-generator system. A vibration-capable spring-mass system is not connected in series with the drive train, but instead is located in a parallel configuration with respect to it. This has the advantage that the elasticity of the drive train is not modified by the action according to the present invention, so that direct influence on the agility of the vehicle is precluded. The spring-mass system forms a canceller (cf. in this regard Magnus, Popp: Schwingungen [Vibrations], Teubner Studienbücher Mechanik, Stuttgart, 1977). The canceller interacts with the torsional vibrations of the drive train.

According to the present invention, energy exchange with the drive train, in particular the mechanical connection between the spring-mass system and other series-connected members of the drive train, occurs between the startup element and the output shaft of the transmission. This on the one hand has the advantage that installation spaces present in any case between the startup element and the transmission output can be used, so that no (or only insignificant) increases in installation space result despite the placement according to the present invention of the canceller. In addition, according to the present invention, interference forces caused by the startup element are attenuated by the canceller on the way to the output shaft.

According to a preferable embodiment of the invention, the startup element is embodied as a hydrodynamic torque converter. In this case the damping influence of the torque converter, which is arranged in a serial configuration in the drive train, can be superimposed on the properties of the canceller. The use of the canceller in conjunction with a converter lockup clutch is advantageous because the canceller can attenuate any power pulses upon closure of the converter lockup clutch. The damping influence of the torque converter is eliminated when the converter lockup clutch is closed, so that by means of the canceller, the torsional vibrations can be influenced or reduced in targeted fashion in this working region of the hydrodynamic torque converter.

According to a refinement of the invention, a torsional damper having two torsional damper stages is placed after the startup element. The torsional damper is located in the power path of the drive train and produces a soft, damped drive train. The embodiment of the torsional damper with two torsional damper stages connected in series allows particularly soft transfer behavior to be achieved, ensuring long travel paths. According to the present invention the spring-mass system is arranged between the first torsional damper stage and the second torsional damper stage. This results in particularly good dynamic transfer behavior. The spring-mass system can moreover be integrated particularly effectively into the installation space provided for the two torsional damper stages, in particular radially between the two torsional damper stages.

A torsional damper is preferably placed after the startup element. In this case the spring-mass system is coupled to the drive train between the torsional damper and a transmission member of a transmission stage. This is preferably the transmission input shaft. For example, the spring-mass system is embodied in accordance with known (tubular) vibration cancelling systems.

In a further drive train according to the present invention, the spring-mass system possesses a damper connected in parallel or in series with respect to a spring of the spring-mass system. The transfer behavior of the drive train can be further influenced by way of the damper. The damper is any nonlinear or linear damper known per se, for example a viscous damper. Alternatively, the spring and the damper can be embodied as one integral component, for example by means of a material that simultaneously possesses resilient and damping properties. Also conceivable is the use of a damper that (at least in part) possesses a dry friction, thereby making possible particularly effective damping of vibrations.

According to a preferable embodiment of the drive train, the spring-mass system is embodied as a torsion canceller. This embodiment represents a particularly simple implementation of the canceller, since the rotary motion of the drive train can be converted directly into the torsional vibrations of the spring-mass system. The torsional oscillator executes rotational vibrations around a shaft of the transmission. This results

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