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[54] **NON-TRACKBOUND VEHICLE WITH AN ELECTRODYNAMIC CONVERTER AND A THROTTLE**

[75] Inventors: **Uwe Adler**, Schweinfurt; **Hans-Jürgen Drexl**, Schonungen; **Dieter Lutz**, Schweinfurt; **Franz Nagler**, Ottendorf; **Martin Ochs**; **Stefan Schiebold**, both of Schweinfurt; **Hans-Joachim Schmidt-Brücken**, Geldersheim; **Wolfgang Thieler**, Hassfurt; **Michael Wagner**, Niederwerrn; **Holger Westendorf**, Hambach; **Rainer Wychnanek**, Madenhausen, all of Germany

[73] Assignee: **Mannesmann Aktiengesellschaft**, Dusseldorf, Germany

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[51] **Int. Cl.**[6] **B60K 1/04**

[52] **U.S. Cl.** **80/65.4**; 318/150

[58] **Field of Search** 180/65.5, 65.4, 180/165, 55.2; 318/150, 139

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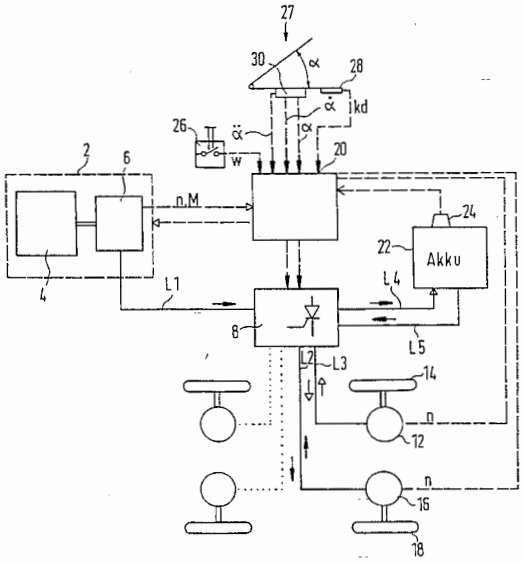
Primary Examiner—Richard M. Camby
Attorney, Agent, or Firm—Cohen, Pontani, Lieberman, Pavane

[57] **ABSTRACT**

A passenger automobile or truck contains a unit which is formed by an internal combustion engine and a generator and which powers electric motors coupled with driving wheels of the vehicle via an energy distributor in the form of power electronics. An accumulator which can likewise be coupled with the electric motors via the energy distributor is provided as an additional power source. An electronic control unit receives driving signals from an accelerator pedal, in particular a position signal and a speed signal. The position signal of the throttle is interpreted as a request for a determined permanent output to be supplied by the internal combustion engine.

The internal combustion engine is revved up to a new operating point in an "optimal" manner (e.g. with favorable fuel consumption), for example when a higher output is requested, while the generator is entirely or partially uncoupled from the load. Energy for accelerating the vehicle is provided in the meantime by the accumulator. The speed signal determines the amount of acceleration. By means of a selector switch, an operation powered exclusively by stored energy may be switched on when the internal combustion engine is turned off if no special sensors are provided for this purpose.

15 Claims, 3 Drawing Sheets



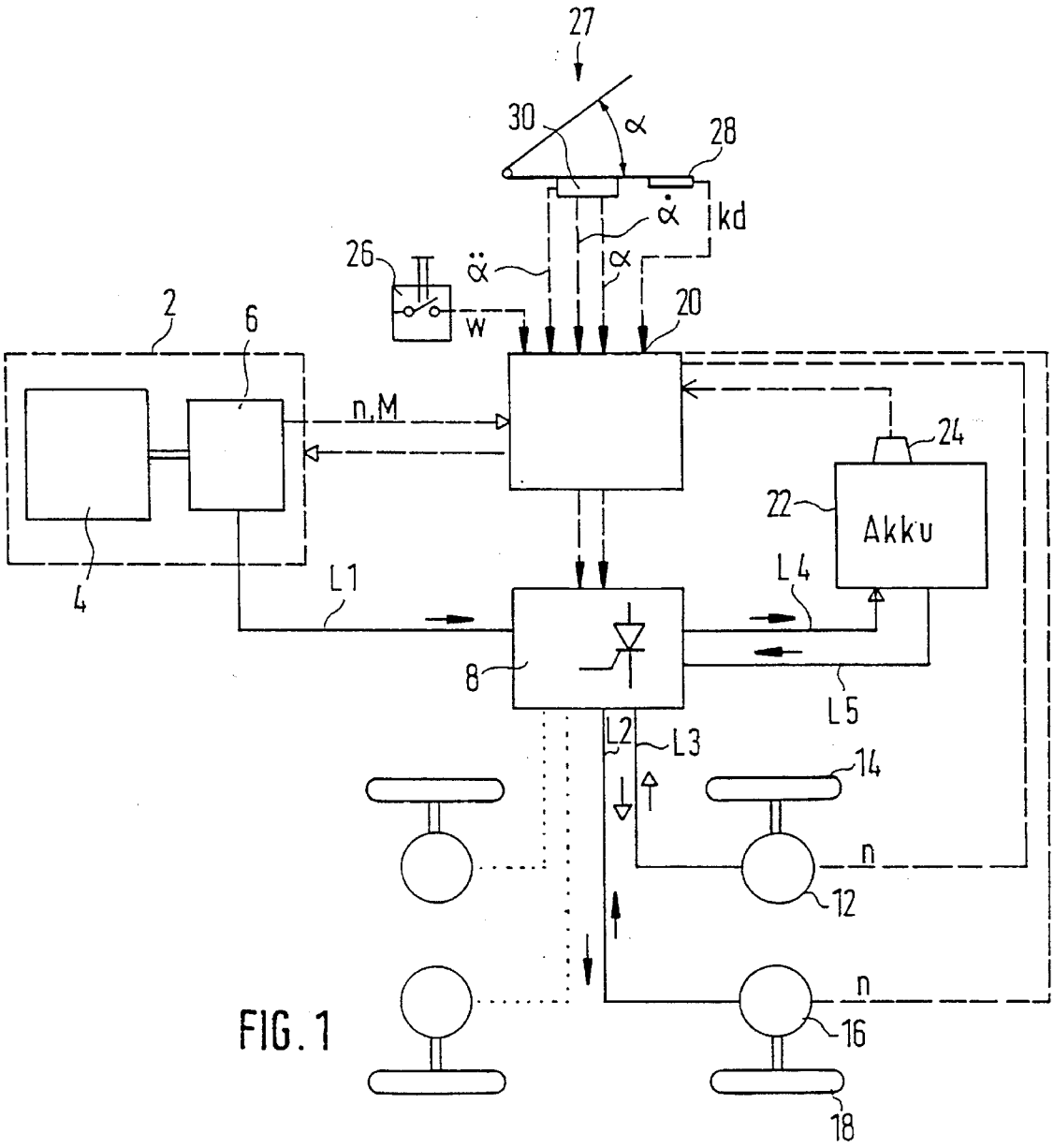


FIG. 1

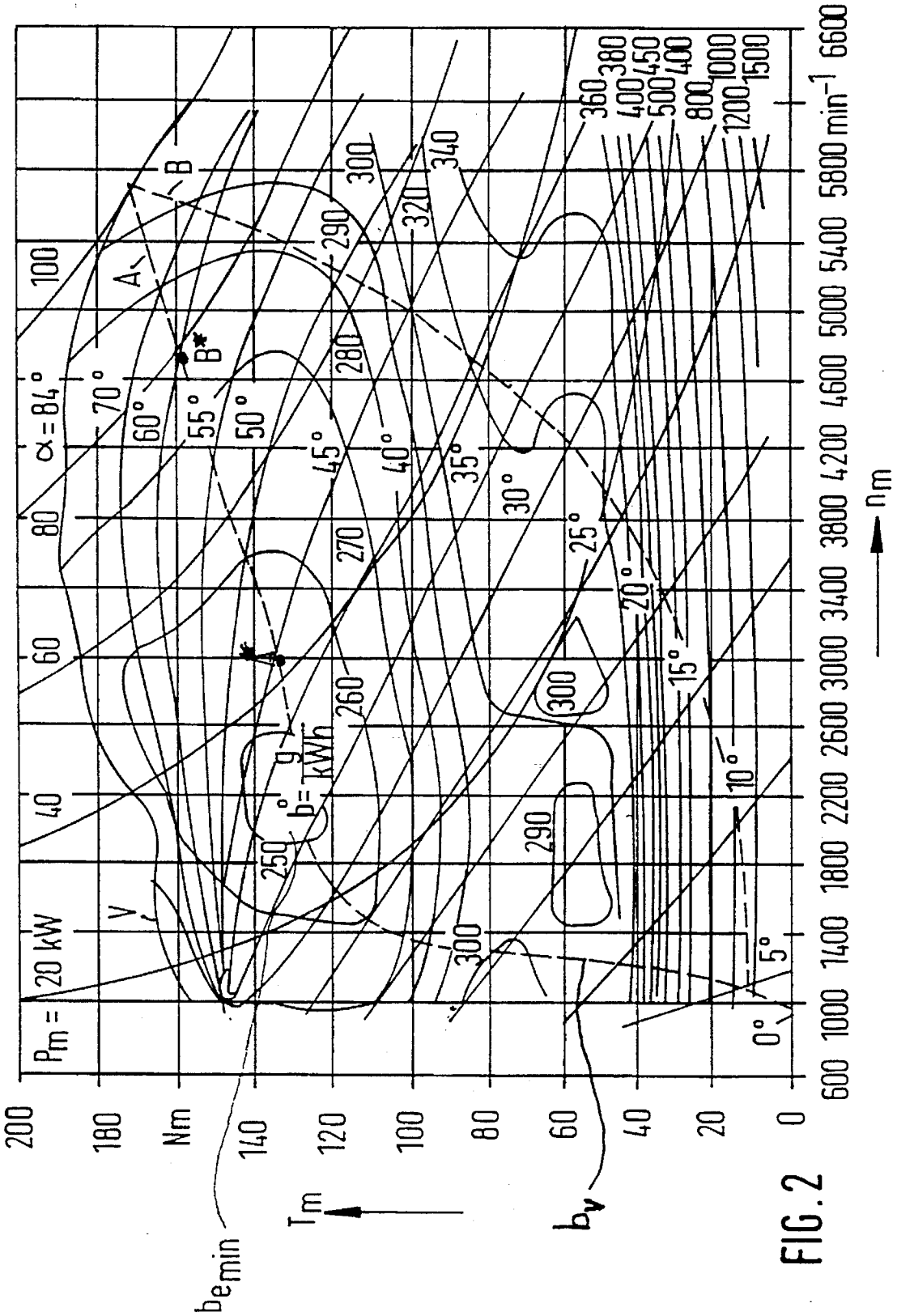


FIG. 2

FIG. 3

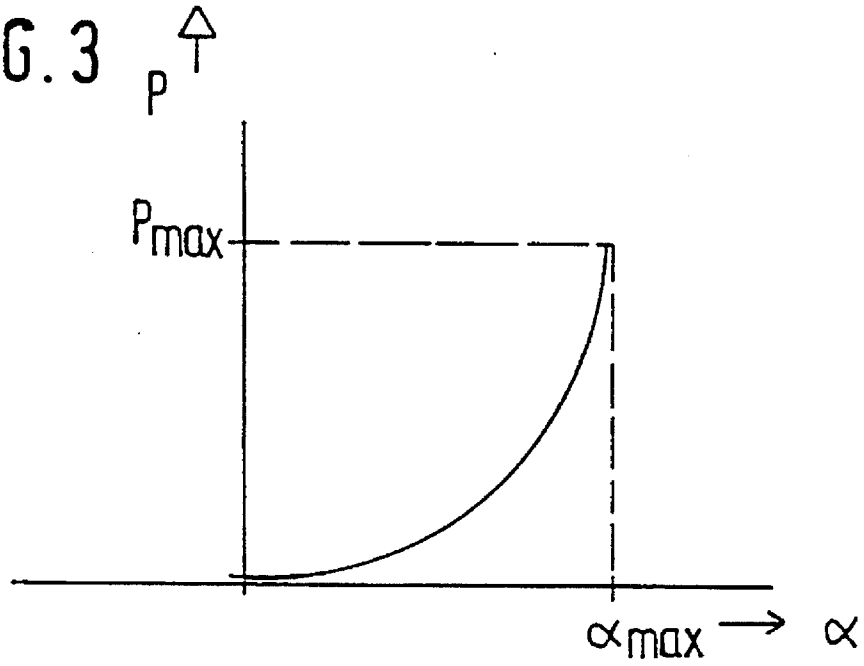
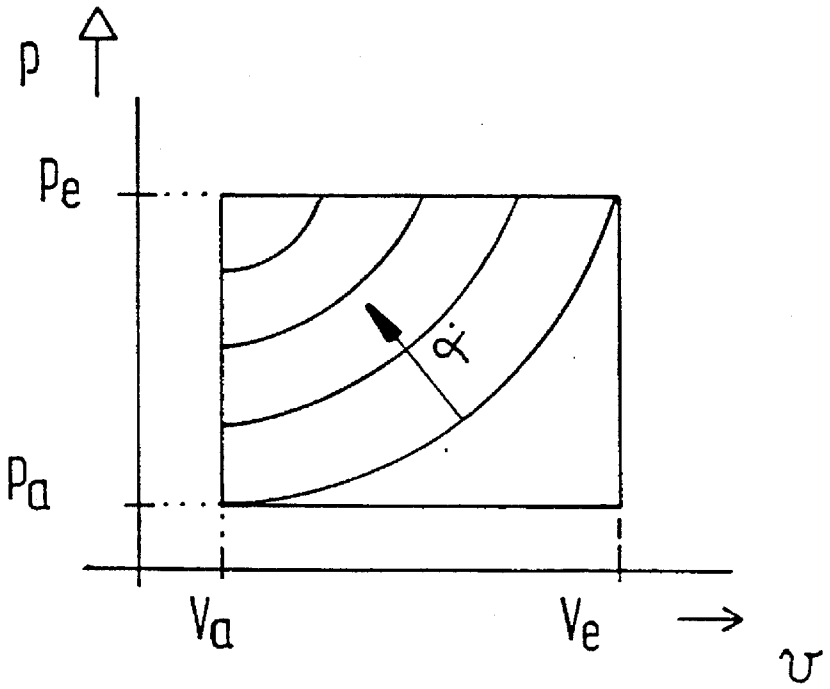


FIG. 4



NON-TRACKBOUND VEHICLE WITH AN ELECTRODYNAMIC CONVERTER AND A THROTTLE

FIELD OF THE INVENTION

The invention relates to non-trackbound vehicles, generally, and more particularly to vehicles having at least one wheel coupled to an electric motor which drives the wheel and which is supplied with current via an energy distributor depending on control signals generated by a control unit, the current being supplied by a generator coupled with an internal combustion engine and the control unit receiving from a throttle a driving signal which is at least representative of the position of the throttle.

DESCRIPTION OF THE PRIOR ART

The most common non-trackbound vehicles are passenger automobiles and trucks. These vehicles were hitherto conventionally operated by internal combustion engines. Internal combustion engines have a characteristic torque/speed curve which, at a determined speed range, has a more or less pronounced torque maximum bordered by regions with greatly reduced torque at higher speeds and especially at lower speeds.

Engine output is calculated as the product of torque and speed. To achieve the fastest possible acceleration of a vehicle, the maximum available output must be transmitted to the driving wheels. When the vehicle engine is operating in a low speed range, only a relatively slow acceleration can take place even at the maximum throttle valve opening, since there is insufficient available output. The output for acceleration can be increased by shifting into a lower gear, since higher speed and accordingly a higher available output are provided in a lower gear. Practically all vehicles having an internal combustion engine are outfitted with a gear shift or automatic transmission to make use of the available output of the engine.

Electric drives which are chiefly used in trackbound vehicles, e.g. in locomotives, have the advantage that the dependency of the output on speed is considerably less pronounced than in internal combustion engines. For this reason, electric drives can generally be utilized without a transmission.

It has already been proposed to drive non-trackbound vehicles, i.e. passenger automobiles, trucks and busses, by means of one or more electric motors which are directly coupled with the wheels. The electric motors are powered by an internal combustion engine/generator unit via an energy distributor constructed as power electronics. A hybrid engine of this kind has a number of advantages. When the wheels are driven by means of electric motors, not only can a gear shift or automatic transmission be dispensed with, but it is also possible with thrusting engine or during a braking process to operate the electric motors as generators so that the occurring electrical output can be used, e.g., for heating or the like.

It has also already been suggested to couple an internal combustion engine with an energy storage constructed as a flywheel in a vehicle. In this case, the internal combustion engine can always be operated in an optimum operating state, e.g. in a range of the most favorable specific fuel consumption. The generator coupled with the internal combustion engine supplies electrical energy to the driving electric motors. When the vehicle is accelerated, additional energy is drawn from the flywheel. During a braking process when the electric motors are operating as generators, energy is obtained from the latter and can be stored in the flywheel as mechanical energy.

In practice, however, former proposals for providing a vehicle having an internal combustion engine with a generator and associated driving electric motors have only been realized in part.

A non-trackbound vehicle is known from DE 40 00 678 A1. This vehicle has an internal combustion engine, an electric generator driven by the latter, an electrically chargeable and dischargeable flywheel storage, at least one electric drive motor, and an energy distributor which is controlled by a control unit and constructed as power electronics. The electric drive motor is powered by the energy distributor with electric current from the generator and/or the flywheel storage. Depending on the charge state of the flywheel storage, the electronic control unit allows the internal combustion engine to run either at idling speed (when the storage is extensively charged) or at a second speed (when the storage is mostly discharged). This second speed represents a quantity which is selected on the basis of optimization criteria (e.g. fuel consumption, pollutant emission).

The concept of a vehicle with electrodynamic converter discussed above is very promising with regard to economizing on energy, pollution abatement and other requirements. However, the driver's readjustment from the customary vehicle with internal combustion engine to a vehicle with quasi-electric drive may be a possible source of problems in the use of such vehicles. Since the vehicle is ultimately driven by electric motors, the vehicle behaves very much like a vehicle with a purely electric drive.

It is therefore an object of the present invention to provide a non-trackbound vehicle of the type mentioned above in which the driver's commands, as expressed by the movement of the throttle, in particular the accelerator pedal, are correctly interpreted and in which means are employed for converting the driver's commands into available output allowing the vehicle to behave in conformity to the driver's commands.

SUMMARY OF THE INVENTION

The aforementioned object, as well as others which will become apparent from the description provided herein, is met by a vehicle in which an energy storage means is provided which is electrically connected, via the energy distributor, with the electric motor and with the generators in that the control unit processes the driving signal in the form of a control signal for the internal combustion engine in order to bring the internal combustion engine to the output corresponding to the position of the throttle or in order to maintain it at this output, and in that the control unit further generates a control signal for taking energy from the energy storage at least so as to allow the internal combustion engine to accelerate to a new operating point in an optimal manner and/or to achieve maximum acceleration of the vehicle and/or to further increase the maximum speed of the vehicle at full engine output.

In accordance with the present invention a determined drive output to is produced fundamentally by the internal combustion engine be allocated to the driving signal, i.e. in particular to the respective angular position of the throttle (accelerator pedal). The driver requests a certain output by actuating the accelerator pedal. The characteristic curve between the demanded output and the position of the accelerator pedal is preferably nonlinear and is relatively flat in

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