Title: ENGINE UNIT FOR HYBRID VEHICLES

Abstract: The present invention refers to an engine unit for hybrid vehicles and to a corresponding hybrid vehicle, in which the arrangement is such as to assure a high efficiency, a remarkable reduction of consumptions and an appreciable reduction of pollutants emission.
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
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ENGINE UNIT FOR HYBRID VEHICLES

DESCRIPTION

The present invention refers to an engine unit for hybrid vehicles.

In the following description, the engine unit according to the present invention will also be referred to with the wording of "electric-turbo-compound" engine, the meaning of which will be evident in the following.

Hybrid vehicles are designed with the object of consuming less fuel emitting less noxious substances and polluting gases, exploiting more rationally the energy of traditional fuels along with the advantages deriving from the use of electrical energy-supplied engines.

To date, there are several categories of hybrid vehicles.

A first category comprises the vehicles in which a conventional endothermic engine drives a generator that in turn feeds an electric motor connected to the driving wheels. However, such vehicles are not characterized by appreciable energy savings. In fact, the efficiency of the generator and of the electric motor is anyhow lower than that of one with an entailed less-than-optimal transmission of power to the wheels.

A second category of hybrid vehicles comprises those vehicles in which the engine drives a generator that stores power in storage batteries, from which it is taken to drive an electric motor connected to the driveline.

These vehicles entail the advantage of recovering kinetic energy during deceleration phases or while covering descents, using the engine as a generator.

A third category of hybrid vehicles comprises those vehicles in which the engine transmits power to the driving wheels and drives a generator recharging the storage batteries and feeding an electric motor, it also connected to the driving wheels. The latter solution, though certainly advantageous with respect to the others, still entails the drawback of being greatly affected by
the higher or lower efficiency of the engine, the latter being the crucial element to the ends of overall efficiency (consumptions, emission of pollutants, etc.)

Hence, object of the present invention is to solve said problems of the known art, by providing an engine unit for hybrid vehicles as defined in independent claim 1.

Secondary features of the present invention are defined in dependent claims thereof.

The present invention further refers to a hybrid vehicle as defined in claim 11.

The present invention, by overcoming the abovementioned problems of the known art, entails several and evident advantages.

The advantages, as well as the features and the operation modes of the present invention will be made apparent from the following detailed description of a preferred embodiment thereof, given by way of a non-limiting example, making reference to the figures of the annexed drawings, wherein:

figure 1 is an exemplary diagram of the engine unit according to the present invention.

Hereinafter, reference will be made to the above figure.

By examining the operation of a conventional engine, it will be evident that only a small fraction of the energy of the fuel utilized is transformed into mechanical energy useful to the vehicle. The remainder is lost via various paths. A sizable percent is lost with coolants. Exhaust gases, by exiting at high temperatures, remove an even higher percentage thereof, in the neighborhood of the 35-40%. Moving components dissipate the remainder by friction or radiance in air.

In short, about 75% of the energy of the fuel utilized is lost.

In order to improve this aspect, the present invention provides a so-called electric-turbo-compound engine unit. According to the present invention, an engine unit 1
comprises an endothermic engine 2, whose exhaust gases are utilized to drive a gas turbine 5. Moreover, the engine unit comprises a generator 6, driven by the turbine, producing electrical energy. This energy is then used to recharge battery packs 7 that in turn are used to feed the electric onboard apparatuses and/or one or more electric motors 8 aiding the drive.

The endothermic volumetric engine 2, Otto-cycle, diesel or rotative, transmits motion directly to the driving wheels of the vehicle. The exhaust gases of the engine 2 set in motion a gas turbine 5, centrifugal, centripetal or axial, with one or more stages. The turbine will drive the generator of electrical energy, energy that could be stored in the batteries or directly used for the drive. Thus, the production of electrical energy is made independent from the endothermic engine. In fact, it is provided an electronic control of the speed rate of the turbine by means of a suitable control unit allowing, above a certain predetermined threshold, to run the turbine itself at its optimum speed rate, for any ratio of the rotation speed rate of the turbine to that of the volumetric engine.

The electric motors 8 aiding the drive are usually fed directly by the generator; however, during the running, there may be provided phases in which the electric motors 8 are supplied via the batteries. This is possible, e.g., to improve vehicle performances in particularly critical phases such as ascents or times at which a higher pickup is required.

Moreover, according to conventional schemes, the electric motors 8 could advantageously be exploited in deceleration stages, working as electrical energy generators.

Of course, one or more electronic control units 9 could be provided for managing the energy flows and the different operation modes that will be described hereinafter. Such control units may reasonably be assumed
to lay within the reach of a person skilled in the art, therefore no description thereof will be provided, also because their implementation will depend each time on the specific applications desired.

The electrical energy supplied by the turbine-driven generator will suffice to do away with the traditional alternator for recharging the battery. Moreover, the electric motor, by being connectable to the driving shaft of the endothermic engine, may also be used as a starter.

A vehicle fitted with an engine unit according to the present invention could advantageously start running driven by the sole electric motor, or by the sole endothermic engine, or by both.

When driven by the sole electric motor, the latter will draw energy from the batteries and the vehicle speed will suffice for circulating in traffic restricted areas, in towns and in parking maneuvers. Upon reaching a certain speed, the endothermic engine can start running.

Since the power of the electric motor adds to the power of the endothermic engine, it will be possible to use smaller endothermic engines, and not oversized ones as is usually the case. Moreover, since the electric motor exhibits a remarkable torque right from low speed rates, advantageously there could be used an engine designed so as to exhibit an improved efficiency at higher speed rates, with an entailed sensible fuel saving in out-of-town running.

Moreover, a vehicle fitted with an electric-turbo-compound engine unit according to the present invention, may easily be turned into a 4x4 drive one, merely by connecting the endothermic engine to one of the shafts and the electric motor to the other shaft. Thus, when both the endothermic engine and the electric motor are running the 4x4 effect will be attained.

Moreover, the electrical energy produced by the batteries could advantageously be used to feed an air compressor, to boost the endothermic engine. An
electrically driven compressor entails the advantage of keeping the boosting at optimal values with respect to the rotation speed rate and to the load of the endothermic engine, as well as of adjusting the same boosting in the acceleration and deceleration stages, to get round the known problem of the response delay of the traditionally boosted engines.

Indirectly, this will allow also additional fuel saving.

An electric-turbo-compound engine unit according to the present invention behaves almost like a two-shaft turbine with piston compressor. Hence, if exhaust valves are opened in advance and engine firing is delayed, gas at a higher temperature will reach the turbine developing a higher power, whereas the engine will decrease in power.

If instead the boosting pressure is increased, engine-injected fuels being equal, in its exhaust duct there will be a higher quantity of available comburent air. Therefore, by injecting fuel into the exhaust duct there can be generated an afterburning that reheats the exhaust gases and increases turbine power.

Moreover, in the case of diesel-type engines or the like producing fine dusts at the exhaust, there may advantageously be provided a trap for the solid particles emitted by the engine in the exhaust, particles burnable in the afterburning in the exhaust duct itself.

It is understood that the different functionalities described hereto could be applied individually or in combination, depending on the specific needs and on the typology of vehicle to be implemented. Moreover, the same functionalities will be managed and controlled, preferably automatically, by means of electronic-type control units on the basis of detections and metering of corresponding chemico-physical parameters.

The present invention has hereto been described according to a preferred embodiment thereof, given by way of a example and not for limitative purposes.
It is understood that other embodiments may be envisaged, all to be construed as falling within the protective scope thereof, as defined by the annexed claims.
CLAIMS

1. An engine unit (1) for hybrid vehicles, comprising:
   - a main engine (2) of endothermic volumetric type,
     fitted with exhaust duct (3) for outletting exhaust
     gases and with members (4) for transmitting motion;
   and
   - a gas turbine (5), mounted along said exhaust duct
     and driven by means of the exhaust gases of the
     engine (2),
   characterized in that it further comprises an electrical
   energy generator (6), mechanically connected to an output
   shaft of said turbine (5) and driven by the turbine (5)
   itself.

2. The engine unit according to claim 1, further
   comprising one or more battery packs (7), connected to an
   electrical outlet of said electrical energy generator (6)
   and apt to store the energy produced during the motion.

3. The engine unit according to claim 1, further
   comprising one or more electric motors (8), fed by said
   electrical energy generator (6), said electric motors (8)
   having a respective output shaft mechanically connected
   to said members (4) for transmitting motion.

4. The engine unit according to claims 2 and 3, wherein
   the electrical energy for feeding said one or more motors
   (8) is drawn from said battery packs (7).

5. The engine unit according to one of the preceding
   claims, further comprising one or more electronic control
   units (9) for managing the energy flows.

6. The engine unit according to one of the preceding
   claims, wherein said endothermic volumetric engine (2)
   may be of Otto-cycle, diesel or rotative type.

7. The engine unit according to one of the preceding
   claims, wherein said gas turbine (5) may be of
   centrifugal, centripetal or axial type, with one or more
   stages.

8. The engine unit according to one of the claims 2 to
7, further comprising an air compressor electrically driven by means of said battery packs, apt to provide compressed air to boost the engine.

9. The engine unit according to claim 8, comprising one or more fuel injectors, apt to inject fuel in said exhaust duct, in order to carry out an afterburning stage.

10. The engine unit according to claim 9, comprising a device for controlling the level of boosting and of injection synchronization during the afterburning.

11. A hybrid vehicle, characterized in that it comprises an engine unit according to one of the claims 1 to 10.