

NSK-RHP



**THE NEXT GENERATION
OF VEHICLE POWER STEERING**

NSK EPAS™

Abstract:

NSK EPAS™ (Electrical Power Assisted Steering), a system which assists steering effort by torque generated from an electric motor, is superior in many respects to conventional HPS (Hydraulic Power Steering). NSK EPAS™ is more efficient as it only consumes energy when required. It is also lighter, and much easier to mount in vehicles. Finally as the system does not rely on hydraulic fluid for its operation, there are no environmental questions as to its safe disposal.

These advantages are of considerable importance to motor manufacturers under commercial pressures to build cars faster and more efficiently. There are also growing legislative pressures to improve vehicle fuel efficiency and to reduce CO₂ emissions.

Introduction:

The NSK EPAS™ system developed by the NSK Group in Japan was seen for the first time in Europe on the MGF mid-engined sports car.

NSK EPAS™ is introduced for the first time on a European family car, Opel Europe's Corsa. The Corsa is a class leading family car and adopts EPAS as a replacement for HPS to achieve economy and environmental objectives.



HPS:

HPS was once a luxury item confined to vehicles in the large and medium range classes. However, in the last few years, its fitment to smaller cars has become more common.

With conventional HPS the power source (i.e. the hydraulic pump) is separated from the steering system. Moreover HPS requires additional equipment including a reservoir, hydraulic cylinders and pipe lines and of course the pump and hydraulic fluid.

The complete system is bulky and heavy, typically adding about 15kg to the weight of a 1000-1300cc vehicle. Apart from this the considerable number of components the system requires, means that HPS is not easy to install into vehicles - especially smaller ones and mid-engined types.

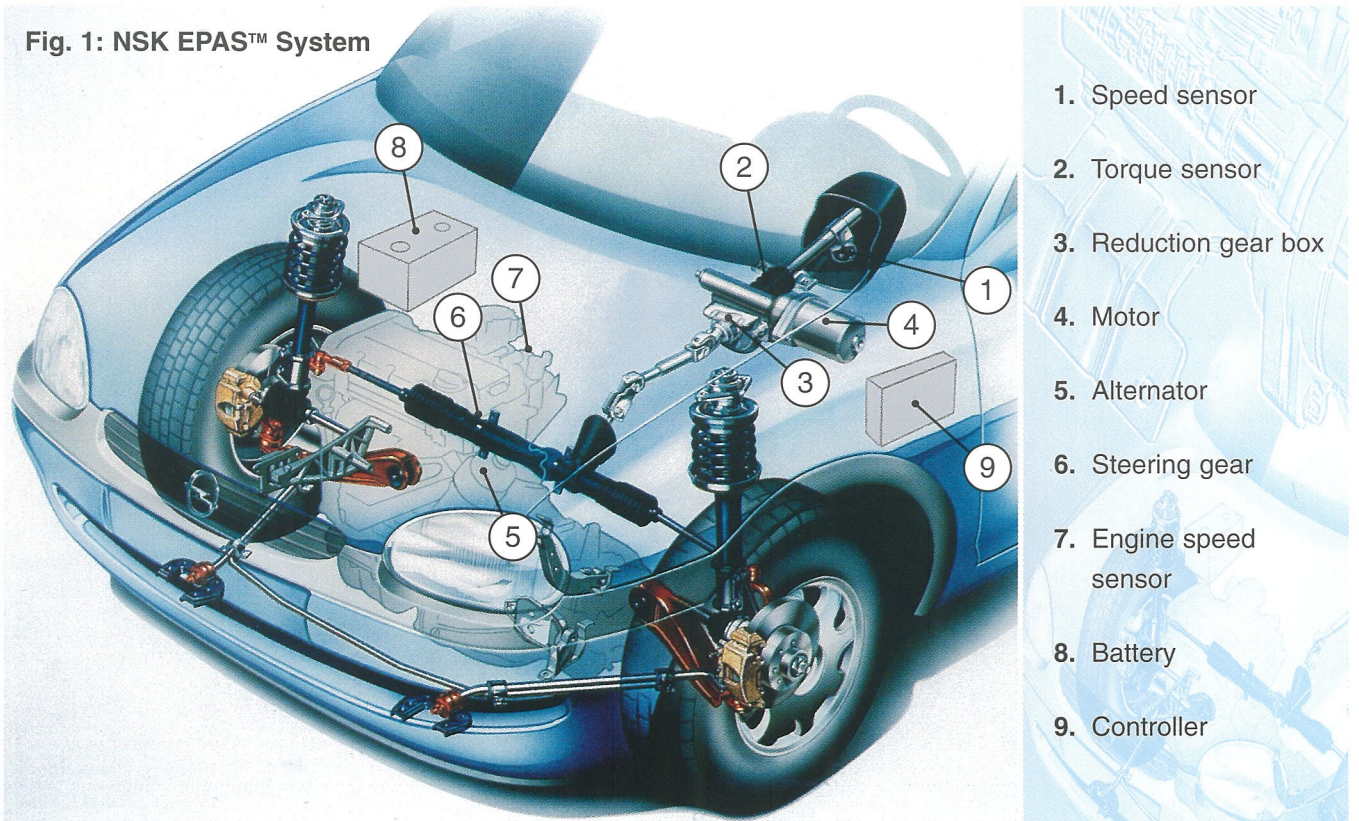
A further undesirable characteristic of HPS is that it consumes engine power at all speeds.

Small front wheel drive vehicles can benefit from power steering but these vehicles can least afford the power drain, nor the additional weight and packaging space required by conventional HPS.

NSK EPAS™:

To overcome the problems associated with HPS the NSK Group has developed NSK EPAS™ (Electrical Power Assisted Steering). In contrast to the former systems, NSK EPAS™ assists the steering effort by torque generated from an electric motor. The NSK EPAS™ system consists of two components: a steering column with an integral electric motor drive system and an ECU (Electronic Control Unit). See Fig. 1 for the layout of the NSK EPAS™ system and the associated components in the Corsa.

Fig. 1: NSK EPAS™ System



The NSK EPAS™ is more compact, easier to install and lighter.

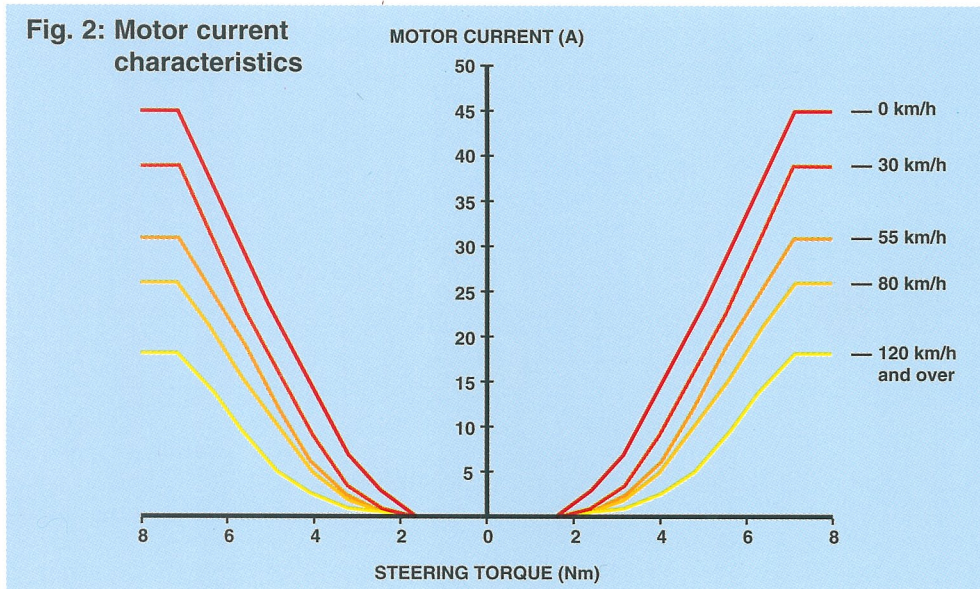
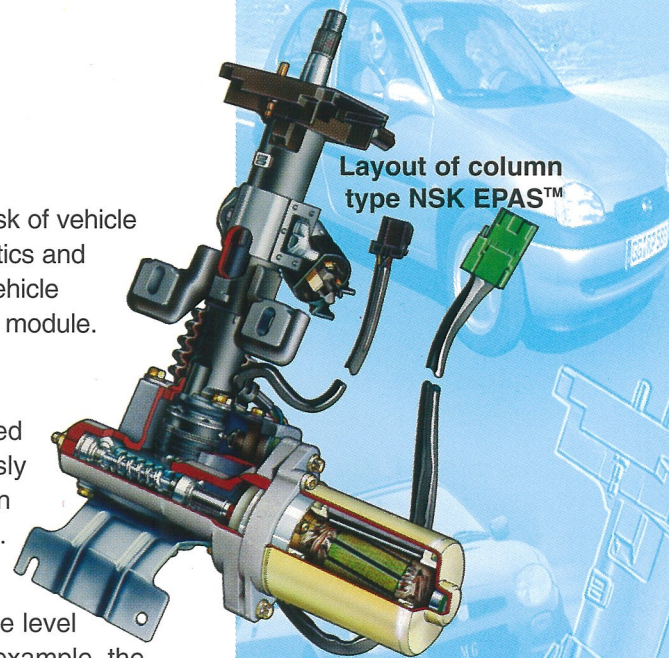
As the NSK EPAS™ system consists of only two components the task of vehicle assembly is simplified. Only two components means simplified logistics and much quicker installation times. Also it is compatible with modular vehicle assembly; the NSK EPAS™ can be incorporated into a cockpit fascia module.

The weight saving of the NSK EPAS™ can be as much as 5kg.

NSK EPAS™ also differs from HPS in that energy is only consumed when demanded. Energy is not wasted driving a pump continuously even when no steering assistance is required. This can provide an improvement in fuel efficiency on most cars of between 2 and 5%. This can also provide an improvement in vehicle acceleration.

The NSK EPAS™ system offers speed sensitive power steering; the level of steering assistance changes with the speed of the vehicle. For example, the system provides maximum assistance during parking manoeuvres and as the vehicle speed increases the level of assistance reduces. This feature is highlighted by Fig. 2 where the vehicle speed increases as the motor current decreases.

NSK EPAS™ has the potential to shorten a vehicle development programme. Tuning of the steering system can be conducted by portable programming tools. This enables quick software changes instead of time consuming HPS hardware changes.



The benefits of NSK EPAS™ when compared to HPS are summarised below;

Advantages of NSK EPAS™ compared to HPS

- *Environmentally friendly*
- *Fail safe system*
- *Fewer parts to manage*
- *Improved packaging*
- *Improved performance*
- *Lower weight*
- *Reduced fuel consumption*
- *Reduced noise*
- *Shorter development programme*
- *Shorter installation time*
- *Speed sensitive*

Layout and operation

The layout and operation of the NSK EPAS™ mechanism is described with reference to Fig 3.

The motor and worm gear (1) are mounted normal to the steering column. The worm wheel (2) is attached to the output shaft (3). The torsion bar (4) connects the steering shaft/input shaft (5) to the output shaft (3).

On applying a torque to the steering wheel the torsion bar will twist and there will be an angular deflection between the input shaft (5) and the output shaft (3). The angular deflection is converted into an axial movement of the sensor ring (6) via the ball (7) and the ball groove (8).

A rotary potentiometer (11) is mounted on the gearbox casing and its lever pin (9) is located in the sensor ring groove (10). The axial movement of the sensor ring is transferred to a rotary movement of the potentiometer. Hence the steering torque is transposed into an electrical output which is proportional to the steering torque.

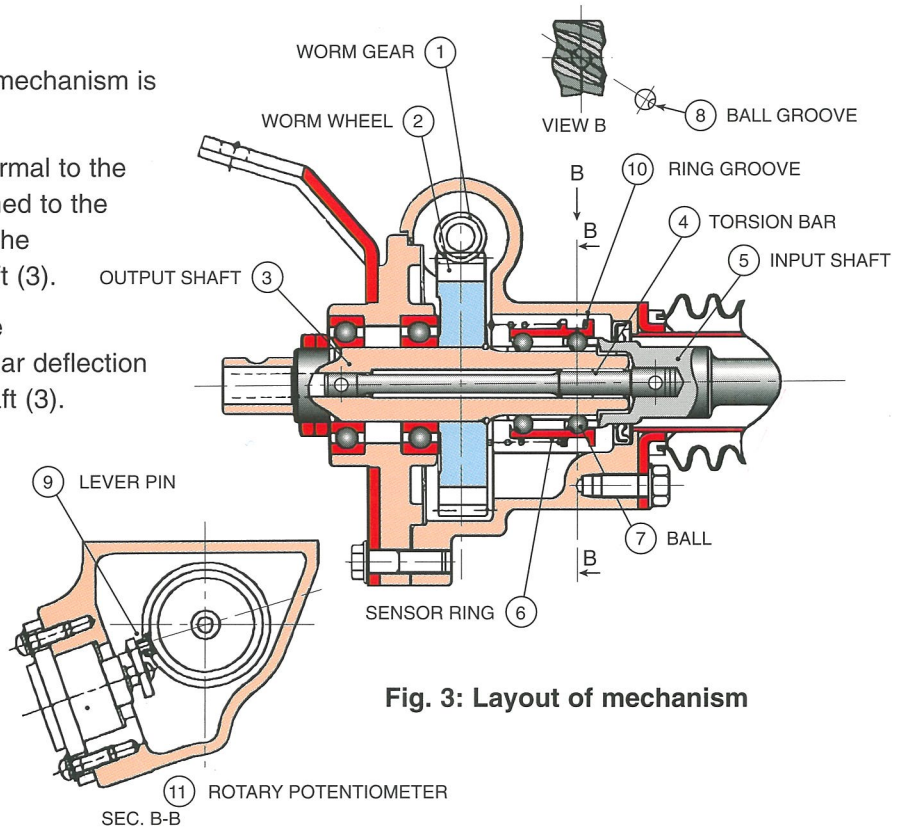
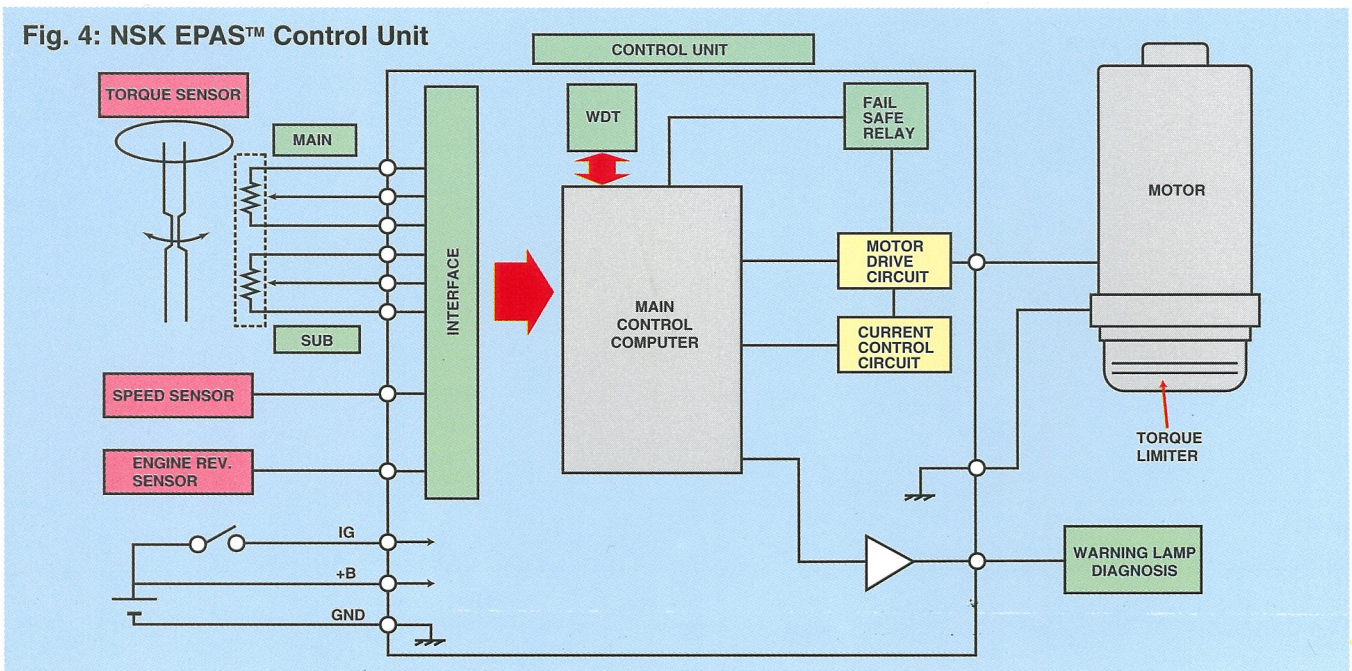


Fig. 3: Layout of mechanism

Fig. 4: NSK EPAS™ Control Unit

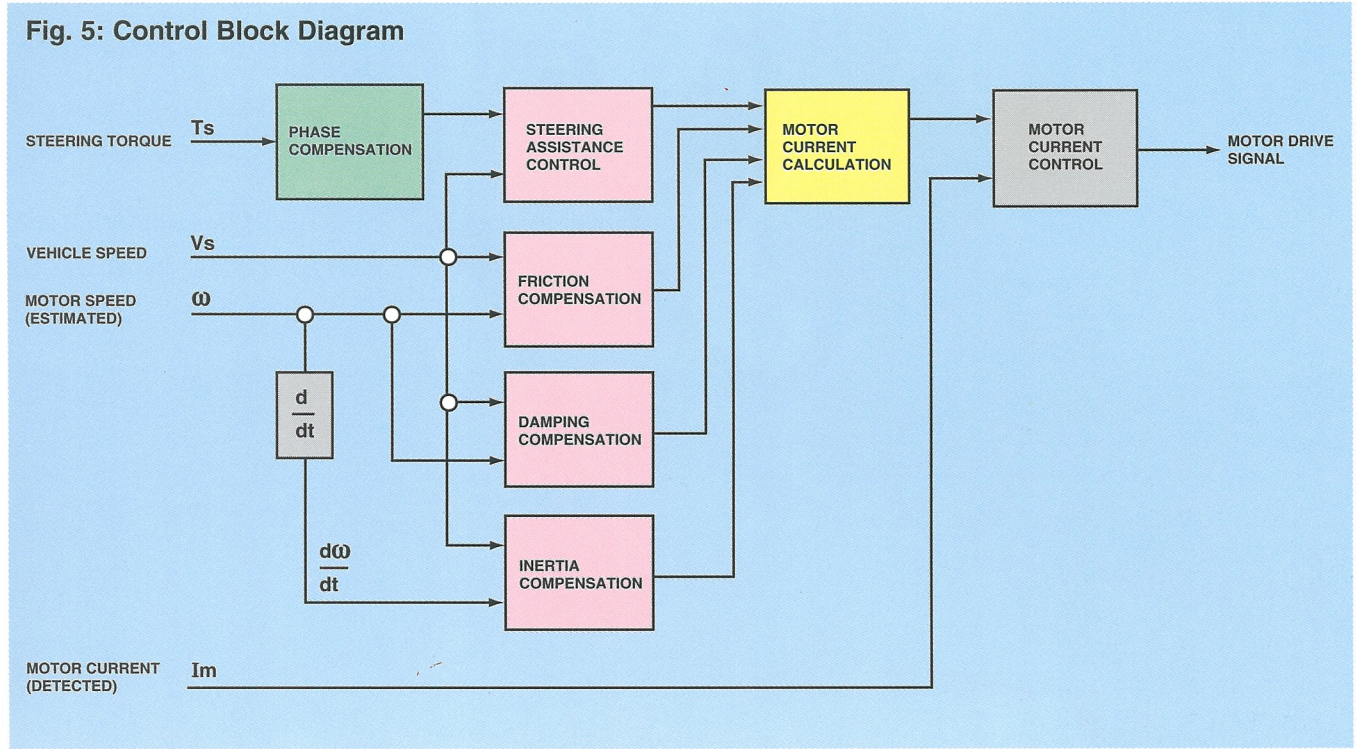


The ECU with its inputs and outputs are shown in block diagram format in Fig. 4. In the ECU the inputs are entered into a calculation circuit where a “mapping” operation with regard to steering torque and vehicle speed is carried out. The direction of the required steering assistance and the motor current are determined. The motor then provides the required torque and the power assistance is applied via the worm gear (1).

The latest generation of NSK EPAS™ system introduces advanced control technology, a more powerful motor and a torque limiter between the motor and the worm gear. The advanced control technology ensures good steering performance with the more powerful motor. A control block diagram is shown in Fig. 5.



Fig. 5: Control Block Diagram



The complete NSK EPAS™ steering column assembly, as fitted to the new G.M. Corsa is shown in Fig. 6.

Noise

The system is quiet in operation. The noises associated with EPS valves and pump are eliminated.

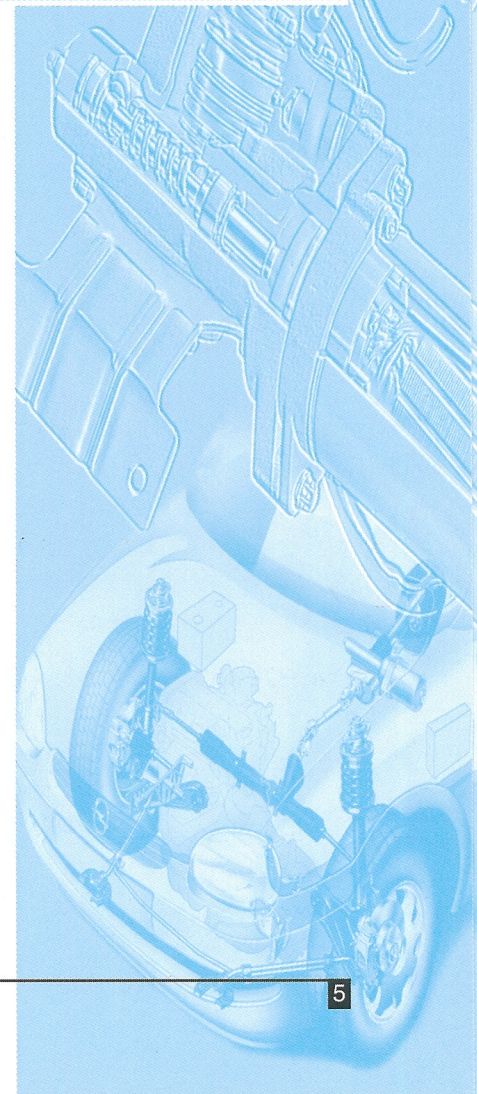
Safety

In the unlikely event of an electrical failure the system is fail safe as manual steering is permanently available.

The system has a continuous self diagnosis capability which is able to detect wiring problems, incorrect connections, short circuits and erroneous speed and torque sensor signals. For example, dual torque sensor circuits are used and the dual signals are continuously monitored by the ECU.

Power assistance is not available unless the engine is running to prevent the battery being discharged.

A safety steering column is incorporated into the NSK EPAS™ system. The NSK Group is a world leader in the design and manufacture of energy absorbing steering columns.



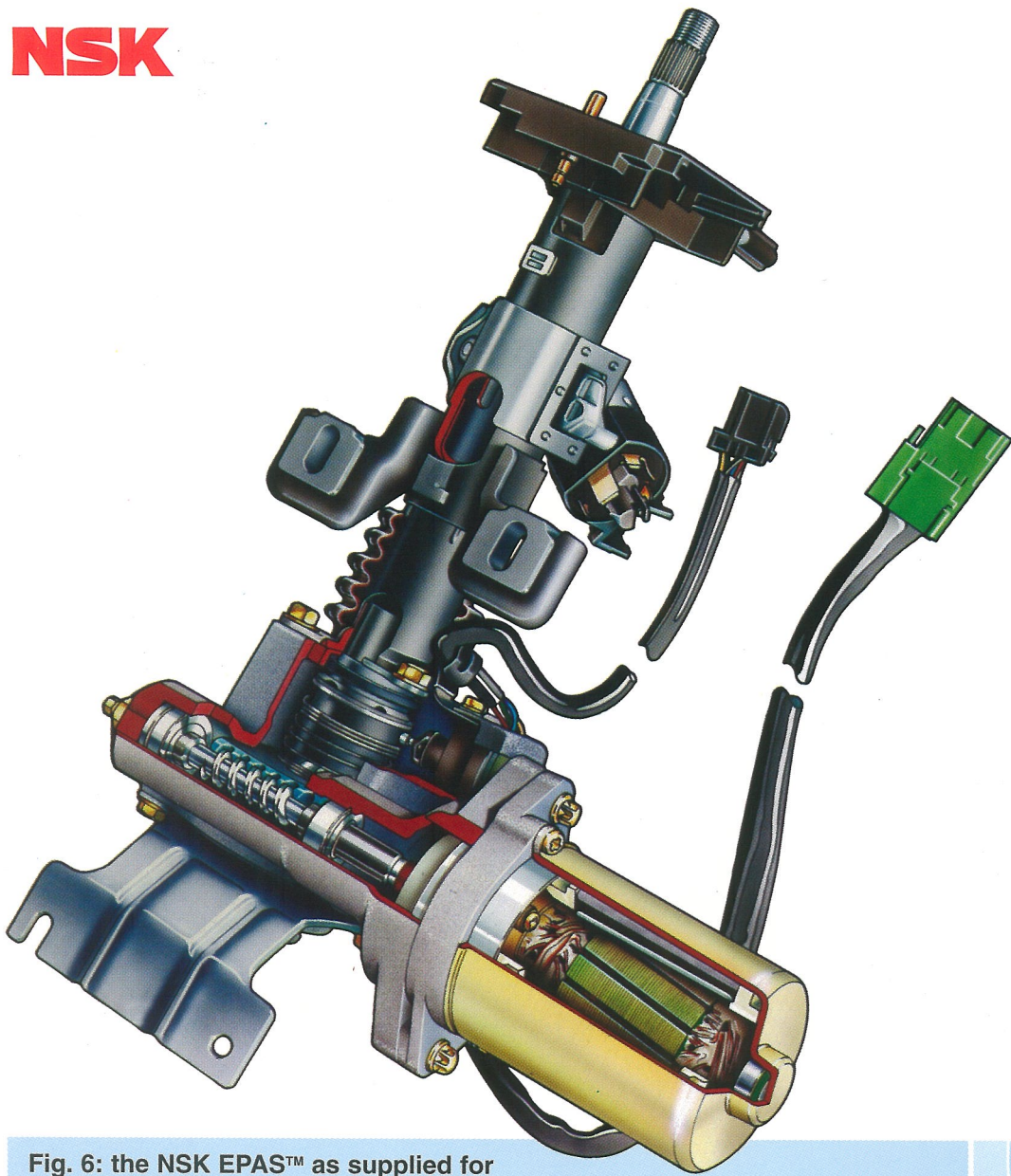
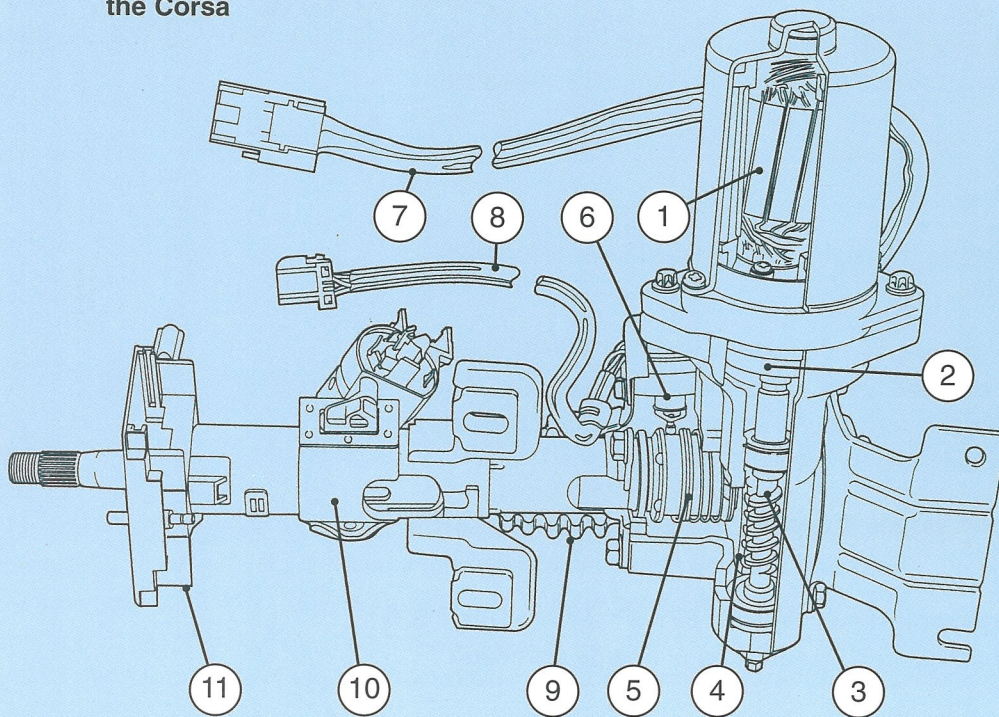


Fig. 6: the NSK EPAS™ as supplied for the Corsa



- 1. Motor
- 2. Torque limiter
- 3. Worm gear
- 4. Worm wheel
- 5. Torque sensor mechanism
- 6. Potentiometer
- 7. Motor harness
- 8. Torque sensor harness
- 9. Energy absorbing convoluted tube
- 10. Keylock assembly
- 11. Indicator switch bracket

Usage

NSK EPAS™ has been used mainly on cars in Japan. It was developed to combat disadvantages of HPS; excessive power consumption and packaging difficulties. Development of NSK EPAS™ is continuous and its advantages have been recognised. NSK EPAS™ is now much in demand.

The MGF application was the first outside Japan and moved the system to a high profile, high performance vehicle.

The introduction of NSK EPAS™ to a class leading European family car, is a further demonstration that NSK EPAS™ is the steering technology of the future.

