European
Patent Office

The Wheel of Invention

booklet accompanying the European Patent Office's interactive travelling exhibition

The Wheel of Invention

Von der Idee zum Patent · From ideas to patents · De l'idée au brevet

Introduction

The European Patent Office

The European Patent Office (EPO) is the executive body of the European Patent Organisation, which was established by the European Patent Convention in 1977. Today the European Patent Organisation has 31 member states (status: 1 July 2005). Patent protection can also be obtained through the EPO for a further five extension states.

The EPO grants patents on behalf of its member states in a centralised procedure. The advantages of this system are that

1. a patent can be obtained in any number of member states on the basis of a single application
2. European patents are sound, offering strong protection for innovative ideas
3. it is generally cheaper for applicants to get a European patent for several member states than it is to make separate national applications.

The number of European patent applications received annually has risen steadily, from 1 000 in 1979 to almost 180 000 in 2004.

What are patents?

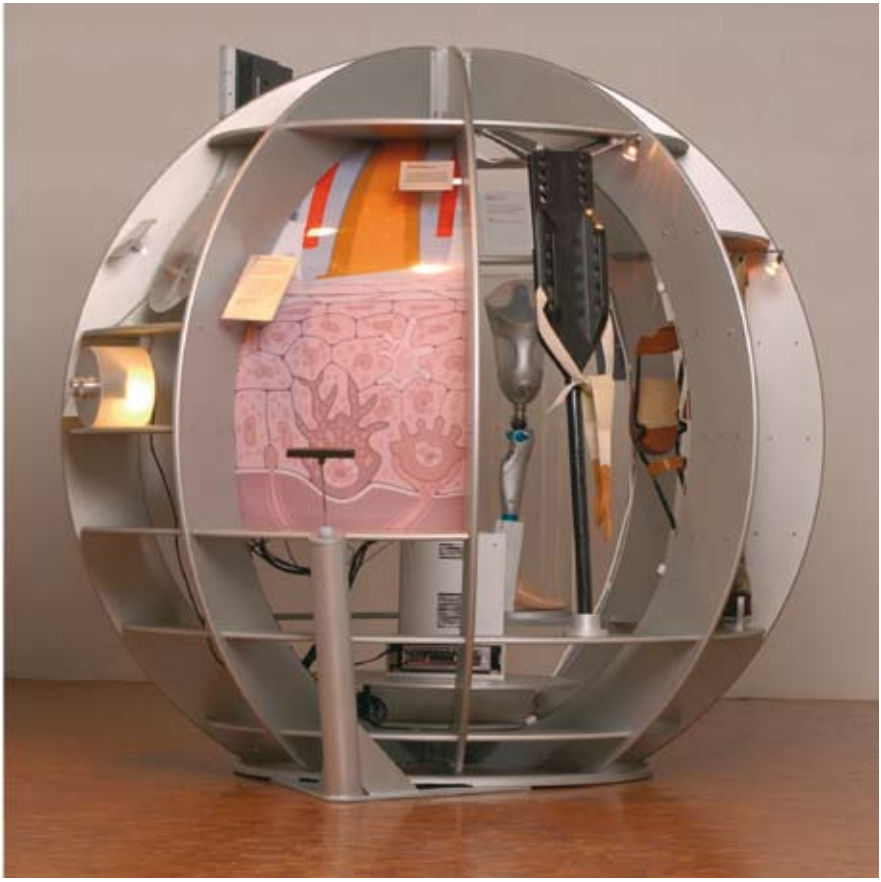
Patents are a form of "intellectual property". They protect technical inventions for up to 20 years from the time of filing by conferring the right to prevent others from making, using or selling an invention. However, patents are subject to national law, so owning a patent does not automatically entitle the proprietor to exploit the patented technology.

Who benefits from patents?

Basically everyone. Inventors have their patent applications published and in return get protection for their ideas. The knowledge disclosed forms part of the state of the art and is freely available in patent databases. These databases are vast repositories of scientific information, containing 80% of the world's technical knowledge.

Patents protect the intellectual property of companies and independent inventors, and ensure that development costs can be recouped. By preventing the unauthorised copying of inventions, they also facilitate the marketing of new ideas. This makes them a key factor in economic growth.

Patents benefit research. They are published to prevent duplicate inventions and to encourage further innovation or improvements to existing inventions. Scientists and developers can also generate licensing revenue from patents, which can be put back into basic research.



1. Medicine

a. Capsule endoscope

Endoscopic equipment allows a visual examination of organs and the body cavity. Until now, this could only be done by inserting the endoscope into the body's natural orifices or by a minor operation. It was not possible to carry out a full examination of the small intestine using endoscopic methods, since rigid endoscopes, inserted from the outside, cannot be guided through the winding intestine, which is about three metres long.

A capsule endoscope, approved for use in Europe since 2001, solves the problem in a completely painless manner. The small capsule is swallowed and conveyed through the digestive tract in eight hours by peristaltic movements before being naturally excreted. On its way through the body, a camera chip takes two pictures per second, creating a total of about 50 000 images. Four LEDs ensure correct illumination and two batteries supply the necessary energy. The images are transmitted from inside the body to a data recorder worn on the person.

This data is uploaded to a computer in the form of a video film, which doctors can then evaluate. A localisation system helps them to pinpoint the exact location of the pictures. This method can be used to identify disorders of the small intestine such as Crohn's disease and tumours.

Patent application: WO 01/65995

Capsule endoscopes, which are disposable, cost around EUR 500. Patients do not have to be kept in hospital for the duration of the examination.

b. Needleless powder injection device

Fear of injections could soon be a thing of the past: a powder injection device, which is still being tested, can painlessly inject vaccines into the skin without using a needle. Helium is used to introduce tiny particles of substances in powder form under pressure directly into the epidermis or outer skin layer. The epidermis is the body's first barrier against infections. The vaccines are delivered by powder injection straight into the antigen-forming defence cells known as the Langerhans cells.

The device contains a cylinder for the helium and a cassette which holds the vaccine. The membrane of the cassette is opened under pressure, and the helium gas, discharged at high velocity, transports the vaccine particles through a nozzle into the skin cells. A seal between device and skin ensures that the gas passes back into a silencer to dampen the bang caused by the membrane tearing.

Since it delivers the vaccine in powder form exactly where it is needed, the device is substantially more effective, so less of the often expensive medicine is required. The injection method is painless and prevents infections, which cannot be ruled out with syringes. In addition, the substances in powder form are simpler to store and transport, being less sensitive than conventional vaccines. This makes this type of vaccination eminently suitable for use in high-risk areas in developing countries.

Patent: WO 02055139

What is a vaccination?

When a person is given a vaccination, they receive a dose of a live virus or bacterium in weakened form. This disease organism is a foreign body, a so-called antigen, which triggers the production of a specific antibody. The body is then prepared for any future infection caused by the bacterium or virus because it "knows" what antibody is needed and can produce it quickly. The antibodies catch the antigens and prevent illness.

c. Prostheses

Since antiquity, people have been trying to replace lost limbs with prostheses. However, the artificial limbs of the past were a poor replacement for the real thing. Today prostheses can imitate natural sequences of movement; their wearers even take part in competitive sport.

Exhibit: peg leg

The peg leg we know from pirate films was a simple mechanical support for people who had lost part of a leg.

Exhibit: simple prosthesis with signs of wear

The prosthesis commonly available after the First World War is anatomically shaped and has a movable joint at the knee. It functions as a support to the body, but walking with it is hardly comfortable or natural.

Exhibit: simple prosthesis with knee joint and foot joints

A joint at the knee with a restoring spring and two sprung joints at the foot gives the wearer greater mobility and flexibility. It is interesting to note how little development and innovation there was in the area of prostheses at a time when the first satellite was already in space.

Exhibit: C-Leg

A computer-assisted leg prosthesis, the C-Leg, makes it possible to approximate to natural walking. The central element of the C-Leg is an intelligent knee joint which uses electronic sensors to collect data, 50 times per second, about the current sequence of movements. On the basis of this data, which is compared with stored movement patterns, a software application uses hydraulics to control the knee. When the heel makes contact with the ground, the artificial knee stiffens; when the wearer moves off, it swings through. The movement of the joint is thus adapted to the wearer's gait, the walking speed and the ground surface.

Patent: EP 0549855

Exhibit: Flex-Foot

The lower leg prosthesis with a flexible carbon foot allows flowing walking movements with a low expenditure of energy. It makes walking and running less tiring than with conventional prostheses. Like muscle, the flexible carbon foot saves the energy generated when lifted and releases it in a way that supports the movement of the prosthesis wearer. In addition, shock absorption reduces the pressure on the stump, and a rotation-damping component elastically slows down rotary motions of the body. Athletes such as golfers, rollerbladers and discus throwers derive particular benefit from this lower leg prosthesis.

Patent: US 4547913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2. Nutrition

a. Transgenic plants

In many countries – led by the USA – genetic engineering is already being exploited commercially in agriculture. This involves the cultivation of transgenic plants, ie plants that have been altered by genetic engineering, with a particularly high yield or resistance to pests or certain herbicides. Plants with a higher nutritional value are also produced in this way. For example, there is a patented process to transfer a gene that determines a particularly high protein content in certain types of bean. This characteristic can be conferred on plants through gene transfer. However, the use of genetic engineering in food production is controversial. Its advocates believe that genetically engineered plants help to solve dietary and environmental problems, but their opponents fear possible risks. There is indeed a danger that released transgenic plants will convey their manipulated genes to other cultivated and wild plants. In addition, long-term health effects such as the emergence of new allergies among consumers cannot be completely excluded. For this reason, the commercial cultivation of genetically engineered plants has so far been banned in the EU.

Nature invented genetic engineering hundreds of millions of years ago. The bacterium Agrobacterium tumefaciens causes tumorous growths in plant crowns by transferring a fragment of its own DNA to the plant's DNA. Biotechnology researchers are now using this characteristic to introduce foreign genes into plants. The desired genetic material is introduced into the plasmid ring, an additional mini-chromosome of the agrobacterium after removal of the disease-causing gene. The bacterium then inserts the new gene into the DNA of the plant cells. After that, the infected plant parts are simply grown on a culture. The resulting plants possess the new characteristics.

Other points relating to biotechnology and genetics:

- The legal framework for the patenting of genes and gene sequences has been in place since 2000. The relevant directive still awaits implementation in eight EU countries.
- For patenting purposes, the invention is deemed new if it was not previously accessible to the public (eg an unknown gene, or an antibiotic).
- While biological material, including isolated human body parts, is expressly patentable, the human body as such is excluded from patenting.
- Genes and DNA are expressly patentable, unlike the purely mechanical process of isolating this material (as in the Human Genome Project). The function of a gene must be known when the patent application is made.
- Plants and animals are generally patentable, provided that the technical feasibility of the invention is not confined to a specific variety. Genetically modified animals are only patentable if the suffering caused by the invention is offset by a significant medical benefit for mankind and/or an animal (as, for example, in the case of the "oncomouse").

b. Electronic nose

The food industry needs either keen noses or sensitive measuring equipment to check the quality of raw materials or their products. A portable electronic nose works more reliably than the human nose. It replaces costly laboratory checks and can be used on-site, ie during the production process or in a warehouse. The nose makes it possible, for example, to determine the level of freshness and the quality of foodstuffs, to measure their smell and to monitor flavouring levels or processing steps. It is also suitable for monitoring "smelly" industrial plants.

The measuring device uses ten metal-oxide sensors to help it identify gases and gas mixtures that are given off by the substances to be measured. The detection of gases in gas sensors is based on chemical reactions between gas particles and special semiconductor surfaces made from metal oxides. These reactions lead to a change in the electrical charge state of the metal-oxide surface. This change is detected electronically.

The signals from the individual gas sensors are evaluated by a program running on a computer hooked up to the device. The software recognises the characteristic composition of the gas measured, converts it into a corresponding image and compares it with stored samples of gas mixtures. Operators of such a device can train the software in accordance with their own requirements. Samples that are to be recognised again can be stored. The device also has a self-cleaning mechanism so that different substances can be measured one after another without mixing the results.

Patent application: DE 10146434

The main advantage of the electronic nose over its human equivalent is that it is not subject to change. If presented with the same smell over an extended period, biological systems begin to adapt: ie the smell becomes familiar, with the result that it is no longer perceived or is perceived in a much milder form. The electronic nose, on the other hand, always retains the same sensitivity, irrespective of how long or how often it has been exposed to the same smell.

c. Vanillin production

For more than 500 years, vanillin, the main aromatic component of the vanilla pod, has been one of our most popular flavourings.

After harvesting, the pods of the orchid plant from Mexico are still completely odourless and tasteless. They only develop their flavour as the result of a fermentation process. Since cultivating and processing vanilla takes a great deal of labour and time, it is, along with saffron, one of the most expensive flavourings in the world. Every year, about 40 tons of vanillin are produced from vanilla pods, but 12 000 tons of vanillin are consumed. The greater part of the flavouring substance is therefore produced much less expensively from other materials.

A German chemist succeeded in producing vanillin artificially as early as 1874. He synthesised it from coniferin, a substance found in the cambial sap of conifers, and was granted the first vanillin patent for his method. Since then, numerous other methods have been developed for producing vanillin. A large proportion of the flavouring is nowadays produced from lignin, the binding agent

in wood. In this process, the lignin-containing sulphite waste liquor obtained when manufacturing paper can, for example, be chemically processed to yield vanillin. Biotechnological processes are an alternative to synthesis. The starting material is eugenol, which is contained in clove oil. Micro-organisms convert this substance first of all into ferulic acid and in a second step into vanillin. This makes it possible to produce a "natural" flavouring which is more expensive but much more popular with consumers.

People cannot tell the difference between vanillin produced by different methods.

Patents for different methods of production:
Patent for coniferin synthesis: German Imperial Patent Office No. 576
Patent for lignin synthesis: GB 465708
Patents for biotechnological processes: DE 3920039; EP 0761817

3. Sport

a. Exercise equipment with articulated frame steering

A new technology which is being used for gym machines, bicycles and children's "walking bikes" requires users to move their body in a fundamentally different way. The reason is that the exercise machine cannot be steered in the usual manner, using the handlebars, and every touch of the pedals results in unintentional cornering. This unusual action of the bike is caused by an articulation that connects the front and rear parts of the machine and enables them to move in relation to each other. These machines are steered using the back and hips in a similar way to a skateboard. In order to move straight ahead, a counterforce must be created via the saddle. This can only be done if the muscles of the back, stomach and arms are co-ordinated.

The complex movements not only train many parts of the muscles; they also provide training for the brain functions involved in co-ordination. Thus, the benefits of exercising on a bike or gym machine are holistic. The muscles of the stomach and back are built up, stamina is improved and the breakdown of fat is promoted. In contrast to the systematic training of individual movements, the training of complex sequences of movements on this machine results in the user moving more fluidly and the movements being in a natural sequence. The ability to concentrate is also improved, as are the user's sense of balance and physical confidence.

The equipment is used for leisure purposes, fitness training, competitive sport, physiotherapy and rehabilitation.
Patent: EP 0910531

b. Displacement mechanism for football pitches

Events such as concerts and shows are increasingly taking place in sports arenas. To use football stadiums multifunctionally and irrespective of the weather, some new arenas even have roofs that can be opened and closed as required. However, events that take place with the roof closed damage the turf. This problem is solved by a process which allows the entire playing surface to be moved in and out of the stadium like a drawer below the grandstands. While the grass recovers in the open air, events can be held inside the stadium. It takes four hours for the 11 000 tons of turf, housed in a concrete basin, to travel the 300 metres outside.

The concrete basin is supported on 400 concrete feet, on the underside of which there are sliding cushions made from PTFE (Teflon®) to reduce friction. The gigantic load thus slides on 16 specially coated tracks. To reduce the friction even further, a lubricant is used that emerges from openings on the sliding cushions. Minute depressions in the orange peel-like coating of the sliding tracks collect the oil film. The pitch is moved by means of shifting devices known as gripper jacks. These are clamped to the sliding tracks and use pistons to push or pull the pitch forward, one stroke at a time. The pistons then move back and the gripper jacks are released and moved on a short distance for the next push.

This technology was successfully implemented for the first time in the Gelredome in Arnhem in the Netherlands, and then in the AufSchalke stadium in Gelsenkirchen (Germany).

Patent: EP0916003

c. Inline skates

Skates for the road – this is what many keen ice-skaters wanted at the beginning of the 19th century. This inspired the French inventor Petitbled to construct a ground skate, the forerunner of the modern inline skate. In 1819 he filed the first patent for an inline skate. His invention had a wooden plate and was fastened to the shoe with leather straps. There were three wheels per shoe, made of wood, metal or ivory. However, this model was mainly for forward travel: turns were only achieved with great difficulty.

A great deal has been accomplished since these first experiments. The inline skate has developed from a mere toy to a serious item of equipment for sports and fitness. Great emphasis is placed on safety and comfort. Just one thing has remained the same – the sheer fun of speeding along on rollers. After being equipped with the ability to turn, the skates were also given brakes. To travel forwards safely, even when going downhill, a person wearing "superskates" can brake by shifting his weight onto his heels. The brake wheel is pressed against the wheels thereby stopping them. For skating in the dark, an LED lighting system can be fitted to the skates. The "softboot" is designed for comfort: the soft, partially reinforced shoes replace the conventional plastic shell. An Italian skate enables the user to choose at any time between walking and skating. In this case, the entire chassis can be separated from the shoe. People who want the choice between skating and cruising can opt for a Swiss model with a built in electric motor that can be switched on to supplement the skater's own efforts.

4. Everyday life

a. Cleaning robot for household use

Who hasn't dreamed of having a team of friendly elves and waking up to a home that is spick and span? The dream is close to becoming a reality: robots which can relieve us of housework already exist. A vacuum cleaner has been developed, and is ready for the market, which can clean floors independently and without supervision. At the rate of 15 square metres per hour, it works more slowly than its human counterpart, but, since it is better at recognising fine dust particles, it cleans floors much more thoroughly. And although it is often in use for hours on end, the device requires significantly less energy than a conventional vacuum cleaner.

The technical demands placed on a robot vacuum cleaner are high. It must be capable of reacting to a constantly changing environment, since, for example, people move furniture round their homes and leave things on the floor. It also needs to recognise where the floor is dirty and how dirty it is.

The cleaning robot moves through a room at random and gradually covers the entire floor area. If it encounters an obstacle, it changes direction. The device is equipped with infrared sensors which prevent it from falling down stairs. Touch sensors ensure that it does not become stuck under furniture. A photo-electric beam in the suction channel measures the proportions of dust and dirt in the air that is sucked in. This enables the vacuum cleaner to recognise soiled areas and to clean them in a targeted manner. If the suction chamber needs to be emptied or the batteries need recharging, the robot moves to its base station; it is guided by an infrared beam emitted by the station.

Patent applications: WO 02/071175; WO 02/069774

b. LED (light emitting diode)

Since the first LEDs came on the market in 1962, their power has increased tenfold each decade while prices have dropped by the same amount. In a few years, if this trend continues, they will be able to compete with traditional lighting systems. LEDs already convert energy into light much more efficiently than incandescent bulbs, as they create less heat. They currently emit about three times as much light, but the target is twenty times the efficiency. This provides considerable potential for energy-saving in the future. The LED also has a longer lifespan. It offers 10 000 hours of light, while a conventional bulb only burns for 1 000 hours.

Light-emitting diodes are based on semiconductor connections. Impurity atoms are incorporated into their crystal lattice and serve as electron donors and electron acceptors. When an electric current is applied, free electrons migrate through the lattice and make new connections. In this process they lose energy, which is emitted as light.

However, LEDs can produce only red, yellow, green or blue light. There are two possible ways of producing white light. One option is to combine red, green and blue LEDs; the resultant light is white. An alternative technique is to coat blue light-emitting diodes with phosphorus. With an effect similar to that of a fluorescent tube, the blue light makes this material glow and yellow light is produced. Since only some of the blue light is converted, the mixture of yellow and blue results in white light.

Patent for white LED: EP 1271664

The light bulb was invented in 1854. Initially, however, the invention went largely unnoticed for lack of reliable power generation. Edison, who reinvented the light bulb in 1879 and patented the idea, made it a commercial success by simultaneously developing the necessary technology to generate and transmit electricity. The light bulb was improved continuously over the following decades, with development more or less complete by 1934, when the coiled-coil filament was invented.

c. Bras

From around 1900, the dress reform movement condemned the constrictive corset and demanded healthier and more comfortable undergarments. However, it was only after the First World War, when the image of women and fashion had changed fundamentally, that bras and girdles replaced the corset. The prevailing fashion was for a boyish appearance, and the bras of the time were intended to flatten the chest.

A model invented by an American woman in 1914 anticipated this development. Her bust-flattening brassiere was tied with ribbons and fastened to a girdle. By the end of the 1920s, the female form was being given renewed emphasis. However, many inventions for this purpose hardly appear practical. For example, a complicated construction from 1928 pushed the breasts upwards using cups fastened to a girdle fitted with rods. In 1935 a female inventor patented foam rubber pads which were inserted into a bra with pockets sewn into it. The trend towards a curvaceous female figure continued after the Second World War. In the 1960s, however, the emphasis shifted again to comfort. A 1963 bra for pregnant women and nursing mothers fulfilled this requirement. It could be adjusted to the changing bust size of its wearer.

Comfort for the wearer continues to be an important criterion in the development of new bras today. A 1997 design was created without seams that dig in; instead, it is bonded, which makes it more comfortable and also reduces manufacturing costs. A bra from 2001 is completely backless and strapless: it is stuck onto the skin complete with padding to give shape and support. Some odd devices for emphasising the bust have also been patented, such as a nipple enhancer worn under a woman's clothing.

5. Mobility

a. Fuel cells to power cars

Cars consume enormous amounts of petroleum and cause environmental problems by emitting pollutants. These problems could be solved by fuel cells, which produce no emissions and use the energy supplied to them much more effectively than internal combustion engines; a further advantage is that they operate quietly.

Fuel cells create electrical energy by a controlled chemical reaction of hydrogen and oxygen. Hydrogen is introduced at the anode of a fuel cell, and oxygen, or air, is introduced at the cathode. The polymer electrolyte membrane (PEM) sandwiched between anode and cathode only allows hydrogen protons through. The excess of electrons results in the anode being negatively charged, while the cathode, as a result of the excess of protons, is positively charged. This produces a voltage, and if both poles are connected outside the cell, an electrical current flows. The electrons migrate through the power supply line to the cathode, where they react with the hydrogen protons and the oxygen to form water. Since an individual fuel cell produces electricity at a low voltage, multiple cells are combined in a stack.

The first cars and buses driven by fuel cells are already in test operation. Different solutions to the problem of fuel storage are being tried out. Many of these vehicles use gaseous hydrogen, which can lead to safety and space problems; others use liquid hydrogen. Another method involves re-forming methanol into hydrogen directly on-board the vehicle, although this produces emissions. The success of fuel cell technology is also hampered by high production costs. A further issue is that the production of hydrogen consumes a great deal of energy. The environment will only benefit when it is possible to use renewable energy sources for this purpose instead of fossil energy sources.

b. Sensors in motor vehicles

The car industry is continually developing new systems to improve traffic safety. Electronics play a central part in the new technologies serving to make motor vehicles safer and more comfortable. Electronic safety systems make up for human weaknesses when driving cars, expand the senses of the driver or protect vehicle occupants when accidents occur. Sensors play a key role here. As the "sensory organs" of the vehicle, they measure numerous factors that influence its behaviour. Physical variables are converted into electrical pulses to supply the systems with the data they need.

Air bags are triggered quickly and reliably because acceleration sensors or pressure sensors detect in fractions of a second whether there is an impact with an obstacle. Driving collisions are prevented by the Adaptive Cruise Control (ACC) system. The car automatically brakes if the radar measuring device signals that the vehicle in front is too close. A parking aid is based on a similar principle. Here, ultrasonic sensors determine the distance from obstacles. ESP, an electronic stability programme, intervenes if there is a risk of the vehicle skidding. The core of this system is a rotational speed sensor. Tyre pressure and tyre temperature sensors can detect whether tyres are gradually losing air. They prevent hazardous blowouts on the road. Pivotable headlights ensure road safety when driving at night: with sensors to determine the yaw rate and the steering angle, the lights can actively follow the curvature of the road. An electronic suspension system intervenes if acceleration sensors in the bodywork measure vertical movements of the vehicle. The system adapts the vehicle's suspension automatically to the driving situation.

Bodywork acceleration sensor: electronic pneumatic system

The electronic pneumatic system adapts the vehicle's suspension to the driving conditions. It takes account not only of the payload, but also of undesirable pitching, as a result of braking or an uneven road surface. An important component of this system is the bodywork acceleration sensor, which measures the vertical acceleration, ie the up-and-down movement of the vehicle.

Tyre pressure and tyre temperature sensor: recognising a drop in tyre pressure

Tyres can lose pressure without the driver noticing. However, since driving can also alter tyre pressure, the system must take several values into account to establish if there really is a problem. When there is a loss of pressure, the tyre radius decreases and the wheel rotates more quickly. Changes are detected by the ABS wheel rotational speed sensors. Detailed measurements can be taken by combining the device with a wheel module that also measures tyre pressure and tyre temperature.

Acceleration sensor: mechanism to deploy the front air bag

In the event of an accident, air bags have to be triggered quickly and safely to protect the occupants of the car. However, the system has to tell the difference between sudden braking and the impact of a crash. This distinction is made by an acceleration sensor that is only activated where there is extreme deceleration. A signal is then given to activate the front air bag.

Pressure sensor: mechanism to deploy the side air bags

Side impact often causes serious and fatal injury. Air bags in the doors can reduce this danger. They are activated by pressure sensors which measure the sudden rise in pressure in the hollow of a door caused when the vehicle is compressed through side impact.

Rotational speed sensor: ESP

ESP, the electronic stability programme, is activated when the car is at risk of skidding. It brakes individual tyres or reduces engine power to stabilise the vehicle. The system is built on a rotational speed sensor, which measures the extent to which the vehicle is turning on its vertical axis. Other sensors measure how much each wheel is turning, the position of the steering wheel and the brake pressure.

Ultrasonic sensors (four generations): parking aid

The parking aid helps motorists to manoeuvre into tight parking spaces without scratching their car's bodywork. It uses ultrasound sensors to recognise obstacles that the driver cannot see. The sensors work like bats, sending out ultrasound signals and picking up an echo. The system calculates the distance from an obstacle on the basis of time difference. The main change in these devices is that they have become smaller over the years, as illustrated by the examples from four generations.

Long range radar: ACC (two generations)

Adaptive Cruise Control (ACC) makes life easier for drivers and improves their concentration at the wheel. The system allows the user to cruise at a chosen speed and keep a set distance from the next vehicle. The car is automatically slowed down or speeded up, depending on the situation. ACC uses a radar sensor to monitor the area in front of the vehicle. On the basis of the reflected signals, the system calculates the direction of travel, the distance from the car ahead and the relative speeds of the two vehicles.

Steering angle sensor and rotational rate sensor: adaptive cornering light

Pivotable headlights make night driving safer. They move in tune with the steering wheel and light up the bends in the road far more effectively than fixed headlights. A steering angle sensor and a rotational rate sensor gather the necessary data on the vehicle's direction of travel.

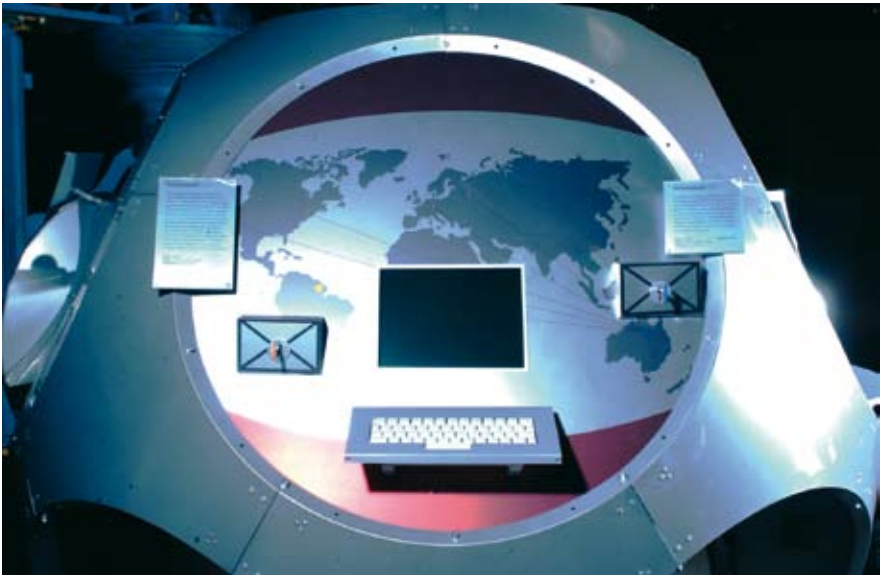
c. Aircraft with a lateral flow fan

This innovative aircraft can take off vertically like a helicopter, but has the gliding characteristics of an aeroplane. The secret lies in a completely novel design. Horizontally arranged rotor blades, reminiscent of a combine harvester, extend over the entire length of the two fixed wings. The whirling rotors move large amounts of air over the upper surface of the rear part of the mainplanes. As with bird flight, the air flows faster over the upper surface of the wing than over its lower surface. The difference in the flow speed reduces the air pressure above the wing. This results in a suction effect, and the aeroplane can take off from a stationary position. During flight, the rotors then serve as giant propellers, which move the aeroplane forwards. The propulsion system of a conventional aeroplane only provides for forward movement. The air on the upper surface of the curved wings is accelerated by the high speeds of motion. This is why aeroplanes need a runway for take-off.

There are many possible uses for the new aircraft. As an aviation workhorse it can transport heavy loads: even with an engine producing a mere 100 HP, it will lift up to two tonnes. It would also be suitable for use as a short-distance air taxi. It flies quietly and, unlike conventional aeroplanes, is not sensitive to turbulence. The fan-wing aircraft consumes little fuel, while its simple construction promises low production costs.

Patrick Peebles, an amateur aviation enthusiast who developed the fan-wing on a kitchen table, has a passion for inventing things. He was granted UK government support for his project.

Patent: GB 2346348



6. Information

a. Polymer chips

The refrigerator keeps a record of its contents and draws the consumer's attention to the expiry dates of the food. Products in the shopping trolley inform the checkout how much they cost. Items of clothing tell the washing machine how they have to be washed. Luggage is checked in automatically at the airport, because suitcases know their destinations. This is made possible by transponder chips, intelligent labels that transmit stored information to a reading device by radio. However, if they are to replace barcodes, to which they are clearly superior, their cost cannot be more than a few cents.

The solution is to make the chips from polymers. Plastic chips are admittedly not as powerful as silicon chips, but have the advantage of being thin, flexible and inexpensive. The electrically conductive or semiconductor properties of certain polymer plastics were discovered over 20 years ago. For this, the chemists Heeger, MacDiarmid and Hideki Shirakawa were rewarded in 2000 with the Nobel Prize.

In the meantime, scientists have been working on finding a way of using a printing process to produce polymer chips inexpensively and in large quantities. Polymers dissolved in solvents can be printed like ink. By a method similar to ordinary offset printing, the four thin layers of the chip are applied one after the other to a flexible substrate (first the electrodes, then a semiconductor layer, then an insulator and finally a further electrode).

Patent for manufacturing process: DE 10033112
Basic patent: US 4222903

b. Asymmetric data encryption (public key cryptography)

Public key cryptography protects data in online banking, e-commerce and e-mails.

In the past, only symmetrical methods of cryptography were available, using the same key to encrypt and decrypt secret messages. This made it necessary to exchange the key as well as the message, so if the key got into the wrong hands, the secret was quickly revealed. This encryption method was inadequate for digital communication, where the participants are often anonymous and the secure exchange of secret keys is generally impossible. In 1976, Diffie and Hellman solved this problem by inventing the public key method, a completely new idea.

The two researchers devised an asymmetric encryption method, in which a pair of related keys are used, of which one is kept secret (private key), while the other is made accessible to the public (public key). The message encoded by the sender, using the public key, can only be decoded by the recipient using his or her private key. This does away with the need to exchange keys. The same method can also be used for the digital signature of documents to identify the sender.

However, it was not possible to use asymmetric cryptography in practice until the invention of the RSA algorithm, for which Rivest, Shamir and Adleman sought a patent in 1977. The RSA algorithm

uses prime numbers to calculate two complementary keys. This algorithm has continued to have a profound influence on security in information technology. In 2002 its inventors were awarded the Turing prize, the most important award in computing science.

c. Human-computer interfaces

Brain-computer interface (BCI)

This device allows the wearer to control a computer through brain signals generated by thoughts. The electrical signals generated by the brain are picked up by electrodes attached to the head. In future, the BCI might not only become a computer input device for the disabled, but could also control prostheses.

3D mouse

In three-dimensional data environments, such as architectural modelling or the representation of virtual reality, the mouse that works in only two dimensions is often no longer sufficient. The 3D mouse enables the user to navigate freely in virtual space. 3D objects can be moved and turned on the screen in all directions. The user's movements are represented exactly as made.

Braille display

The Braille line is the monitor for the blind. This device translates letters on the screen into Braille code so that the information can be read by touch. A navigation bar enables users to find their way around the screen.

Virtual keyboard

The virtual keyboard makes it much easier to enter data in devices such as mobile phones, PDAs or computers. The device projects a virtual keyboard onto any smooth surfaces, and an integrated infrared system detects which letters are being typed and transfers them to the attached device.

7. Environment

a. Propulsion kites for cargo shipping

Cargo ships should be able to make fuel savings of up to 50% in future by using propulsion kites. To make additional use of wind power, a kite sail filled with helium, half the size of a football pitch, floats up to 500 metres above the ship. The innovative drive system harnesses the high wind speeds at this altitude to save energy and reduce emissions that harm the environment. This environmentally friendly technology is still in the test phase.

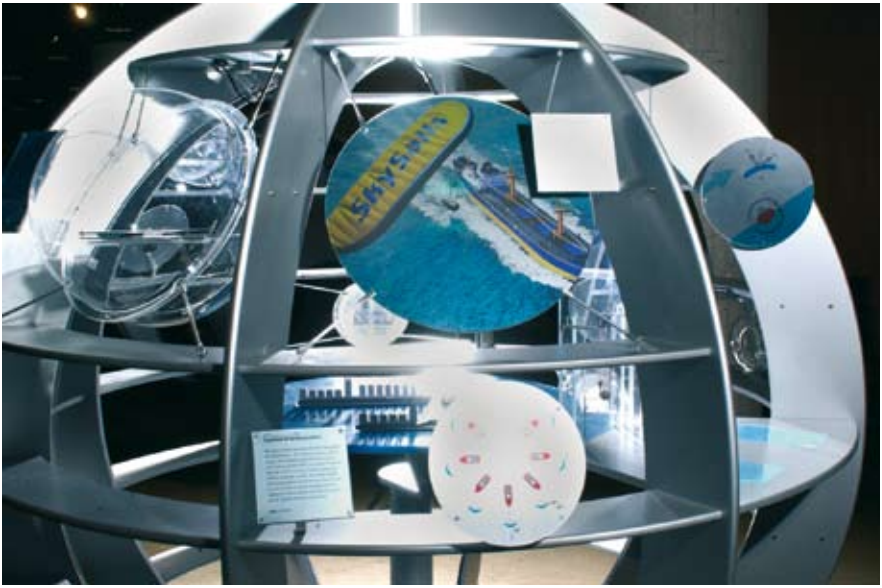
The idea of using the wind to drive ships is an old one – for a long time, sails were the most important means of propulsion for shipping. However, conventional sails are not suitable for modern cargo ships, with stacked-up loads which raise their centre of gravity and make them unstable. Crosswinds pose a particular threat to cargo ships with sails, as they can cause the ships to list and keel over. In contrast, kite sails do not impair stability. The kite creates a lifting force that offsets any listing.

A central tractive cable transfers the power from the kite to the ship. Via steering lines and a flexible fastening system, with a guide rail along the side of the ship, the traction direction can be adapted to the course of the ship and the direction of the wind. The propulsion kite is controlled automatically by an autopilot system like those used in aviation.

International patent application: WO 0192102

b. Dye solar cells

As in photosynthesis, in which light is converted into chemical energy by means of the green pigment chlorophyll, dye solar cells convert light into electrical energy via a dye. This innovative process for generating energy takes place between two thin conductive glass sheets which act as electrodes. A 10µm thin layer of titanium dioxide is applied to one of these glass sheets, known as the front electrode. This layer is nanoporous, ie permeated with minute channels. The surface area of the titanium dioxide, increased 1 000-fold as a result, is coated with an extremely thin layer of dye. When light falls on the dye, it is stimulated and emits electrons into the titanium dioxide. The electrons are transported through the layer of metal to the front electrode and via the outer electrical circuit reach the second sheet of glass, which acts as a counter-electrode. There they are collected by a liquid, an electrolyte that fills the space between the two sheets of glass. The electrons are then available again to return the dye to its original state. Energy can be channelled off from the resultant electrical circuit. At present, the efficiency rate is 8% but this should increase to 12% over time. Conventional silicon solar cells have an efficiency rate of between 11% and 17% but are considerably more expensive to produce.



c. Micro-organisms and enzymes

Biotechnology has developed an entirely new approach to environmental protection. It uses micro-organisms or their enzymes to break down environmental poisons or to replace harmful processes by drawing on these organisms' natural way of life and living conditions. They often present a more economical, efficient and environmentally friendly alternative to chemical methods. It should be noted that it is not the micro-organisms that are patented but their uses and the processes involving them.

Rod-shaped bacteria of the species Pseudomonas putida are used to clean water contaminated with mercury. They convert the dissolved mercury into its metallic form to produce droplet deposits.

Cotton, linen or hemp can be cleaned using an enzyme derived from micro-organisms. This enzyme removes dirt from the cell wall without damaging the fibres.

Some micro-organisms such as pseudomonads and enterobacteria have genes that produce cellulose. Since wood is the usual source of cellulose, these micro-organisms could help to reduce the number of trees felled.


SuperStar
Colgate

8. Production

a. 3D printers

A three-dimensional printing method makes it quick and easy to build models.

When developing new products, industry is dependent on prototypes, which are used to test the design or construction, to examine functionality and to detect faults at an early stage. Traditional model building is increasingly being superseded by rapid prototyping, using various methods to produce models quickly. 3D printers offer a particularly time-saving and inexpensive process: they can be used not only to create single- or multi-coloured models but also to produce moulds and cores for casting metal parts.

The printer can convert a digital drawing into a three-dimensional model in a few minutes or hours, depending on the size of the object. First of all, a computer program mathematically breaks down the three-dimensional drawing into individual layers. The printer then gradually builds up these layers. It uses the same printing process as an inkjet printer. Instead of ink, however, it prints a liquid binder onto a powder material. In the printing process, a thin layer of powder is first applied to a platform and the surplus material is wiped off. The print head prints the binder corresponding to the first layer onto this powder base. The platform is then lowered and a new layer of powder is applied. The process is repeated until the model has been built up layer by layer. No supporting geometry is required even for delicate and complex parts, since the developing model lies securely in the bed of powder.

Patent: US 5387380

b. Plugs and anchors

Almost everyone has them at home and relies on them when hanging pictures or fixing up shelves and cupboards. Before the invention of the plug, the DIY enthusiast had to make do with nails or to chisel a hole in the wall and seal it with wood to provide a surface into which a screw could be driven. There are now any number of patented fixing systems, offering solutions for a vast range of problems.

As early as 1956, Artur Fischer was granted a patent for his versatile and still widely used expansion plug. In the meantime, things have become even simpler with a new general-purpose plug. This can be knocked into the wall as a screw/plug component without drilling. Many of the patented plugs, also called anchors, are of no help in the home, but are indispensable in the building industry. Heavy loads are usually held by metal anchors, the grip of which is partly additionally improved by chemical components introduced into the drill hole. For fixing air-inflated structures, anchors which fix up to three tonnes on the ground can be used. The special tube is driven into the ground and then forced open. The resulting cavity is filled with liquid concrete, as a result of which the fixing system, expanded by up to five times its original diameter, is firmly anchored in the ground.

New materials and consumer demand have given rise to ever more specialised developments. Thus there are metal plugs which are suitable, for example, for sanitary and heating engineering. The use

of glass as a facade element produced a plate anchor which does away with the need to drill the glass. The fixing of insulating materials posed further problems. Special plugs avoid damage to the insulating material and prevent thermal bridges.

c. Microproduction plant

Microfactories could one day replace large-scale chemical production plants. Many chemical processes can be controlled much more effectively on a smaller scale. This increases product yield and purity and spares resources.

Microcomponents with different functionalities can be put together as required to form complex microproduction plants.

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