Hall effect

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*For the Colombian band, see*[*The Hall Effect (band)*](http://en.wikipedia.org/wiki/The_Hall_Effect_(band))*.*

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The **Hall effect** is the production of a [voltage](http://en.wikipedia.org/wiki/Voltage) difference (the **Hall voltage**) across an [electrical conductor](http://en.wikipedia.org/wiki/Electrical_conductor), transverse to an [electric current](http://en.wikipedia.org/wiki/Electric_current)in the conductor and a [magnetic field](http://en.wikipedia.org/wiki/Magnetic_field) perpendicular to the current. It was discovered by [Edwin Hall](http://en.wikipedia.org/wiki/Edwin_Hall) in 1879.[[1]](http://en.wikipedia.org/wiki/Hall_effect#cite_note-1)

The Hall coefficient is defined as the ratio of the induced [electric field](http://en.wikipedia.org/wiki/Electric_field) to the product of the current density and the applied magnetic field. It is a characteristic of the material from which the conductor is made, since its value depends on the type, number, and properties of the [charge carriers](http://en.wikipedia.org/wiki/Charge_carriers) that constitute the current.

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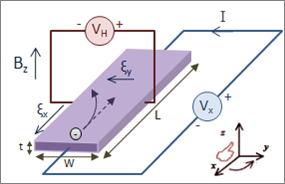
Discovery[[edit](http://en.wikipedia.org/w/index.php?title=Hall_effect&action=edit&section=1)]

The Hall effect was discovered in 1879 by [Edwin Herbert Hall](http://en.wikipedia.org/wiki/Edwin_Hall) while he was working on his doctoral degree at [Johns Hopkins University](http://en.wikipedia.org/wiki/Johns_Hopkins_University) in [Baltimore](http://en.wikipedia.org/wiki/Baltimore), [Maryland](http://en.wikipedia.org/wiki/Maryland).[[2]](http://en.wikipedia.org/wiki/Hall_effect#cite_note-bridgeman-momoir-2) His measurements of the tiny effect produced in the apparatus he used were an experimental [tour de force](http://en.wiktionary.org/wiki/tour_de_force), accomplished 18 years before the [electron](http://en.wikipedia.org/wiki/Electron) was discovered.

Theory[[edit](http://en.wikipedia.org/w/index.php?title=Hall_effect&action=edit&section=2)]

The Hall effect is due to the nature of the current in a conductor. Current consists of the movement of many small [charge carriers](http://en.wikipedia.org/wiki/Charge_carrier), typically [electrons](http://en.wikipedia.org/wiki/Electron), [holes](http://en.wikipedia.org/wiki/Electron_hole), [ions](http://en.wikipedia.org/wiki/Ion) (see[Electromigration](http://en.wikipedia.org/wiki/Electromigration)) or all three. When a magnetic field is present that is not parallel to the direction of motion of moving charges, these charges experience a force, called the[Lorentz force](http://en.wikipedia.org/wiki/Lorentz_force).[[3]](http://en.wikipedia.org/wiki/Hall_effect#cite_note-3) When such a magnetic field is absent, the charges follow approximately straight, 'line of sight' paths between collisions with impurities, [phonons](http://en.wikipedia.org/wiki/Phonons), etc. However, when a magnetic field with a perpendicular component is applied, their paths between collisions are curved so that moving charges accumulate on one face of the material. This leaves equal and opposite charges exposed on the other face, where there is a scarcity of mobile charges. The result is an asymmetric distribution of charge density across the Hall element that is perpendicular to both the 'line of sight' path and the applied magnetic field. The separation of charge establishes an [electric field](http://en.wikipedia.org/wiki/Electric_field) that opposes the migration of further charge, so a steady [electrical potential](http://en.wikipedia.org/wiki/Electrical_potential) is established for as long as the charge is flowing.

In the [classical](http://en.wikipedia.org/wiki/Classical_electromagnetism) view, there are only electrons moving in the same average direction both in the case of electron or hole conductivity. This cannot explain the opposite sign of the Hall effect observed. The difference is that electrons in the upper bound of the [valence band](http://en.wikipedia.org/wiki/Valence_band) have opposite [group velocity](http://en.wikipedia.org/wiki/Group_velocity) and [wave vector](http://en.wikipedia.org/wiki/Wave_vector) direction when moving, which can be effectively treated as if positively charged particles (holes) moved in the opposite direction to that of the electrons.

[](http://en.wikipedia.org/wiki/File:Hall_Effect_Measurement_Setup_for_Electrons.png)

Hall Effect measurement setup for electrons. Initially, the electrons follow the curved arrow, due to the magnetic force. At some distance from the current-introducing contacts, electrons pile up on the left side and deplete from the right side, which creates an electric field ξy. In steady-state, ξy will be strong enough to exactly cancel out the magnetic force, so that the electrons follow the straight arrow (dashed).

For a simple metal where there is only one type of [charge carrier](http://en.wikipedia.org/wiki/Charge_carrier) (electrons) the Hall voltage *VH* can be computed by setting net[Lorentz force](http://en.wikipedia.org/wiki/Lorentz_force) to zero as below -

\mathbf{F} = q\left(\mathbf{E} + \mathbf{v} \times \mathbf{B}\right) = 0 where

E = VH/w, v = L/T, I = Q/T, Q = n Lwt e

Therefore,

V_H = -\frac{IB}{nte}

where *I* is the current across the plate length, *B* is the magnetic field, *t* is the thickness of the plate, \, e is the [elementary charge](http://en.wikipedia.org/wiki/Elementary_charge), and *n* is the [charge carrier density](http://en.wikipedia.org/wiki/Charge_carrier_density) of the carrier electrons.

The Hall coefficient is defined as

R_H =\frac{E_y}{j_xB}

where *j* is the [current density](http://en.wikipedia.org/wiki/Current_density) of the carrier electrons, and E_y is the induced electric field. In SI units, this becomes

R_H =\frac{E_y}{j_xB}= \frac{V_Ht}{IB}=-\frac{1}{ne}.

(The units of *R*H are usually expressed as m3/C, or Ω·cm/[G](http://en.wikipedia.org/wiki/Gauss_(unit)), or other variants.) As a result, the Hall effect is very useful as a means to measure either the carrier density or the magnetic field.

One very important feature of the Hall effect is that it differentiates between positive charges moving in one direction and negative charges moving in the opposite. The Hall effect offered the first real proof that electric currents in metals are carried by moving electrons, not by protons. The Hall effect also showed that in some substances (especially [p-type semiconductors](http://en.wikipedia.org/wiki/P-type_semiconductor)), it is more appropriate to think of the current as positive "[holes](http://en.wikipedia.org/wiki/Electron_hole)" moving rather than negative electrons. A common source of confusion with the Hall Effect is that holes moving to the left are really electrons moving to the right, so one expects the same sign of the Hall coefficient for both electrons and holes. This confusion, however, can only be resolved by modern quantum mechanical theory of transport in solids.[[4]](http://en.wikipedia.org/wiki/Hall_effect#cite_note-4)

The sample inhomogeneity might result in spurious sign of the Hall effect, even in ideal [van der Pauw](http://en.wikipedia.org/wiki/Van_der_Pauw_method) configuration of electrodes. For example, positive Hall effect was observed in evidently n-type semiconductors.[[5]](http://en.wikipedia.org/wiki/Hall_effect#cite_note-5) Another source of artifact, in uniform materials, occurs when the sample's aspect ratio is not long enough: the full Hall voltage only develops far away from the current-introducing contacts, since at the contacts the transverse voltage is shorted out to zero.

**Hall effect in semiconductors**[[edit](http://en.wikipedia.org/w/index.php?title=Hall_effect&action=edit&section=3)]

When a current-carrying [semiconductor](http://en.wikipedia.org/wiki/Semiconductor) is kept in a magnetic field, the charge carriers of the semiconductor experience a force in a direction perpendicular to both the magnetic field and the current. At equilibrium, a voltage appears at the semiconductor edges.

The simple formula for the Hall coefficient given above becomes more complex in semiconductors where the carriers are generally both [electrons](http://en.wikipedia.org/wiki/Electrons) and [holes](http://en.wikipedia.org/wiki/Electron_hole) which may be present in different concentrations and have different [mobilities](http://en.wikipedia.org/wiki/Electron_mobility). For moderate magnetic fields the Hall coefficient is[[6]](http://en.wikipedia.org/wiki/Hall_effect#cite_note-Kasap2001-6)

R_H=\frac{p\mu_h^2 - n\mu_e^2}{e(p\mu_h + n\mu_e)^2}

or equivalently

R_H=\frac{(p-nb^2)}{e(p+nb)^2}

with

b=\frac{\mu_e}{\mu_h}.

Here \, n is the electron concentration, \, p the hole concentration, \, \mu_e the electron mobility, \, \mu_h the hole mobility and \, e the elementary charge. For large applied fields the simpler expression analogous to that for a single carrier type holds.

**Relationship with star formation**[[edit](http://en.wikipedia.org/w/index.php?title=Hall_effect&action=edit&section=4)]

Although it is well known that magnetic fields play an important role in star formation, recent research[[7]](http://en.wikipedia.org/wiki/Hall_effect#cite_note-7) shows that Hall diffusion critically influences the dynamics of gravitational collapse that forms protostars.

**Quantum Hall effect**[[edit](http://en.wikipedia.org/w/index.php?title=Hall_effect&action=edit&section=5)]

*Main article:*[*Quantum Hall effect*](http://en.wikipedia.org/wiki/Quantum_Hall_effect)

For a two-dimensional electron system which can be produced in a [MOSFET](http://en.wikipedia.org/wiki/MOSFET), in the presence of large [magnetic field](http://en.wikipedia.org/wiki/Magnetic_field) strength and low [temperature](http://en.wikipedia.org/wiki/Temperature), one can observe the quantum Hall effect, which is the [quantization](http://en.wikipedia.org/wiki/Quantum_mechanics) of the Hall voltage.

**Spin Hall effect**[[edit](http://en.wikipedia.org/w/index.php?title=Hall_effect&action=edit&section=6)]

*Main article:*[*Spin Hall effect*](http://en.wikipedia.org/wiki/Spin_Hall_effect)

The spin Hall effect consists in the spin accumulation on the lateral boundaries of a current-carrying sample. No magnetic field is needed. It was predicted by [M. I. Dyakonov](http://en.wikipedia.org/w/index.php?title=M._I._Dyakonov&action=edit&redlink=1) and[V. I. Perel](http://en.wikipedia.org/w/index.php?title=V._I._Perel&action=edit&redlink=1) in 1971 and observed experimentally more than 30 years later, both in semiconductors and in metals, at cryogenic as well as at room temperatures.

**Quantum spin Hall effect**[[edit](http://en.wikipedia.org/w/index.php?title=Hall_effect&action=edit&section=7)]

*Main article:*[*Quantum spin Hall effect*](http://en.wikipedia.org/wiki/Quantum_spin_Hall_effect)

For [mercury telluride](http://en.wikipedia.org/wiki/Mercury_telluride) two dimensional quantum wells with strong spin-orbit coupling, in zero magnetic field, at low temperature, the Quantum spin Hall effect has been recently observed.

**Anomalous Hall effect**[[edit](http://en.wikipedia.org/w/index.php?title=Hall_effect&action=edit&section=8)]

In [ferromagnetic](http://en.wikipedia.org/wiki/Ferromagnetism) materials (and [paramagnetic](http://en.wikipedia.org/wiki/Paramagnetism) materials in a [magnetic field](http://en.wikipedia.org/wiki/Magnetic_field)), the Hall resistivity includes an additional contribution, known as the **anomalous Hall effect** (or the**extraordinary Hall effect**), which depends directly on the [magnetization](http://en.wikipedia.org/wiki/Magnetization) of the material, and is often much larger than the ordinary Hall effect. (Note that this effect is *not* due to the contribution of the [magnetization](http://en.wikipedia.org/wiki/Magnetization) to the total [magnetic field](http://en.wikipedia.org/wiki/Magnetic_field).) For example, in nickel, the anomalous Hall coefficient is about 100 times larger than the ordinary Hall coefficient near the Curie temperature, but the two are similar at very low temperatures.[[8]](http://en.wikipedia.org/wiki/Hall_effect#cite_note-8) Although a well-recognized phenomenon, there is still debate about its origins in the various materials. The anomalous Hall effect can be either an *extrinsic* (disorder-related) effect due to [spin](http://en.wikipedia.org/wiki/Spin_(physics))-dependent [scattering](http://en.wikipedia.org/wiki/Scattering) of the [charge carriers](http://en.wikipedia.org/wiki/Charge_carrier), or an *intrinsic* effect which can be described in terms of the [Berry phase](http://en.wikipedia.org/wiki/Geometric_phase) effect in the crystal momentum space (*k*-space).[[9]](http://en.wikipedia.org/wiki/Hall_effect#cite_note-sinitsyn-08jpa-9)

**Hall effect in ionized gases**[[edit](http://en.wikipedia.org/w/index.php?title=Hall_effect&action=edit&section=9)]

(See [electrochemical instability](http://en.wikipedia.org/w/index.php?title=Electrochemical_instability&action=edit&redlink=1))

The Hall effect in an ionized gas ([plasma](http://en.wikipedia.org/wiki/Plasma_(physics))) is significantly different from the Hall effect in solids (where the **Hall parameter** is always very inferior to unity). In a plasma, the Hall parameter can take any value. The Hall parameter, *β*, in a plasma is the ratio between the electron [gyrofrequency](http://en.wikipedia.org/wiki/Gyroradius), Ω*e*, and the electron-heavy particle collision frequency, *ν*:

\beta=\frac {\Omega_e}{\nu}=\frac {eB}{m_e\nu}

where

* *e* is the [elementary charge](http://en.wikipedia.org/wiki/Elementary_charge) (approx. 1.6 × 10−19 C)
* *B* is the magnetic field (in [teslas](http://en.wikipedia.org/wiki/Tesla_(unit)))
* *me* is the [electron mass](http://en.wikipedia.org/wiki/Electron) (approx. 9.1 × 10−31 kg).

The Hall parameter value increases with the magnetic field strength.

Physically, the trajectories of electrons are curved by the [Lorentz force](http://en.wikipedia.org/wiki/Lorentz_force). Nevertheless when the Hall parameter is low, their motion between two encounters with heavy particles ([neutral](http://en.wikipedia.org/wiki/Neutral_particle) or [ion](http://en.wikipedia.org/wiki/Ion)) is almost linear. But if the Hall parameter is high, the electron movements are highly curved. The [current density](http://en.wikipedia.org/wiki/Current_density) vector, *J*, is no longer colinear with the [electric field](http://en.wikipedia.org/wiki/Electric_field)vector, *E*. The two vectors *J* and *E* make the **Hall angle**, *θ*, which also gives the Hall parameter:

\beta = \tan(\theta).

Applications[[edit](http://en.wikipedia.org/w/index.php?title=Hall_effect&action=edit&section=10)]

[Hall probes](http://en.wikipedia.org/wiki/Hall_probe) are often used as [magnetometers](http://en.wikipedia.org/wiki/Magnetometer), i.e. to measure magnetic fields, or inspect materials (such as tubing or pipelines) using the principles of [magnetic flux leakage](http://en.wikipedia.org/wiki/Magnetic_flux_leakage).

Hall effect devices produce a very low signal level and thus require amplification. While suitable for laboratory instruments, the [vacuum tube](http://en.wikipedia.org/wiki/Vacuum_tube) [amplifiers](http://en.wikipedia.org/wiki/Amplifier) available in the first half of the 20th century were too expensive, power consuming, and unreliable for everyday applications. It was only with the development of the low cost [integrated circuit](http://en.wikipedia.org/wiki/Integrated_circuit) that the Hall effect sensor became suitable for mass application. Many devices now sold as [Hall effect sensors](http://en.wikipedia.org/wiki/Hall_effect_sensor) in fact contain both the sensor as described above plus a high gain [integrated circuit](http://en.wikipedia.org/wiki/Integrated_circuit) (IC) amplifier in a single package. Recent advances have further added into one package an [analog-to-digital converter](http://en.wikipedia.org/wiki/Analog-to-digital_converter) and [I²C](http://en.wikipedia.org/wiki/I%C2%B2C) (Inter-integrated circuit communication protocol) IC for direct connection to a [microcontroller](http://en.wikipedia.org/wiki/Microcontroller)'s I/O port.

**Advantages over other methods**[[edit](http://en.wikipedia.org/w/index.php?title=Hall_effect&action=edit&section=11)]

Hall effect devices (when appropriately packaged) are immune to dust, dirt, mud, and water. These characteristics make Hall effect devices better for position sensing than alternative means such as optical and electromechanical sensing.

[](http://en.wikipedia.org/wiki/File:HallEffCurrentSense.jpg)

Hall effect current sensor with internal integrated circuit amplifier. 8 mm opening. Zero current output voltage is midway between the supply voltages that maintain a 4 to 8 Volt differential. Non-zero current response is proportional to the voltage supplied and is linear to 60 amperes for this particular (25 A) device.

When electrons flow through a conductor, a magnetic field is produced. Thus, it is possible to create a non-contacting current sensor. The device has three terminals. A sensor voltage is applied across two terminals and the third provides a voltage proportional to the current being sensed. This has several advantages; no additional resistance (a [*shunt*](http://en.wikipedia.org/wiki/Shunt_(electrical)), required for the most common current sensing method) need be inserted in the primary circuit. Also, the voltage present on the line to be sensed is not transmitted to the sensor, which enhances the safety of measuring equipment.

**Disadvantages compared with other methods**[[edit](http://en.wikipedia.org/w/index.php?title=Hall_effect&action=edit&section=12)]

Magnetic flux from the surroundings (such as other wires) may diminish or enhance the field the Hall probe intends to detect, rendering the results inaccurate. Also, as Hall voltage is often on the order of millivolts, the output from this type of sensor cannot be used to directly drive actuators but instead must be amplified by a [transistor](http://en.wikipedia.org/wiki/Transistor)-based circuit.

**Contemporary applications**[[edit](http://en.wikipedia.org/w/index.php?title=Hall_effect&action=edit&section=13)]

Hall effect sensors are readily available from a number of different manufacturers, and may be used in various sensors such as rotating speed sensors (bicycle wheels, gear-teeth, automotive speedometers, electronic ignition systems), fluid [flow sensors](http://en.wikipedia.org/wiki/Flow_sensor), [current sensors](http://en.wikipedia.org/wiki/Current_sensor), and [pressure sensors](http://en.wikipedia.org/wiki/Pressure_sensor). Common applications are often found where a robust and contactless switch or potentiometer is required. These include: electric [airsoft](http://en.wikipedia.org/wiki/Airsoft) guns, triggers of electropneumatic [paintball guns](http://en.wikipedia.org/wiki/Paintball_marker), go-cart speed controls, smart phones, and some global positioning systems.

**Ferrite toroid Hall effect current transducer**[[edit](http://en.wikipedia.org/w/index.php?title=Hall_effect&action=edit&section=14)]

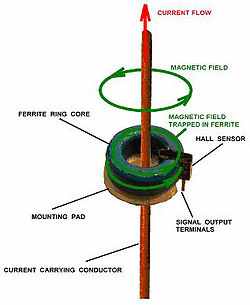
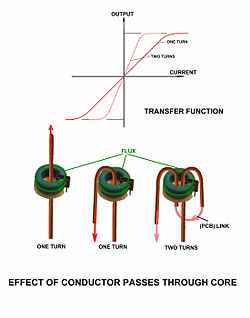
[](http://en.wikipedia.org/wiki/File:RAZC-GENARRv1.jpg)

Diagram of Hall effect current transducer integrated into ferrite ring.

Hall sensors can detect stray magnetic fields easily, including that of Earth, so they work well as electronic compasses: but this also means that such stray fields can hinder accurate measurements of small magnetic fields. To solve this problem, Hall sensors are often integrated with magnetic shielding of some kind. For example, a Hall sensor integrated into a ferrite ring (as shown) can reduce the detection of stray fields by a factor of 100 or better (as the external magnetic fields cancel across the ring, giving no residual [magnetic flux](http://en.wikipedia.org/wiki/Magnetic_flux)). This configuration also provides an improvement in signal-to-noise ratio and drift effects of over 20 times that of a bare Hall device. The range of a given feedthrough sensor may be extended upward and downward by appropriate wiring. To extend the range to lower currents, multiple turns of the current-carrying wire may be made through the opening, each turn adding to the sensor output the same quantity; when the sensor is installed onto a printed circuit board, the turns can be carried out by a staple on the board. To extend the range to higher currents, a current divider may be used. The divider splits the current across two wires of differing widths and the thinner wire, carrying a smaller proportion of the total current, passes through the sensor.

[](http://en.wikipedia.org/wiki/File:Ampere-Turnsv1.jpg)

Multiple 'turns' and corresponding transfer function.

**Split ring clamp-on sensor**[[edit](http://en.wikipedia.org/w/index.php?title=Hall_effect&action=edit&section=15)]

A variation on the ring sensor uses a [split sensor](http://en.wikipedia.org/wiki/Current_clamp#Hall_effect) which is clamped onto the line enabling the device to be used in temporary test equipment. If used in a permanent installation, a split sensor allows the electric current to be tested without dismantling the existing circuit.

**Analog multiplication**[[edit](http://en.wikipedia.org/w/index.php?title=Hall_effect&action=edit&section=16)]

The output is proportional to both the applied magnetic field and the applied sensor voltage. If the magnetic field is applied by a solenoid, the sensor output is proportional to the product of the current through the solenoid and the sensor voltage. As most applications requiring computation are now performed by small [digital computers](http://en.wikipedia.org/wiki/Computer), the remaining useful application is in power sensing, which combines current sensing with voltage sensing in a single Hall effect device.

**Power measurement**[[edit](http://en.wikipedia.org/w/index.php?title=Hall_effect&action=edit&section=17)]

By sensing the current provided to a load and using the device's applied voltage as a sensor voltage it is possible to determine the power dissipated by a device.

**Position and motion sensing**[[edit](http://en.wikipedia.org/w/index.php?title=Hall_effect&action=edit&section=18)]

Hall effect devices used in motion sensing and motion limit switches can offer enhanced reliability in extreme environments. As there are no moving parts involved within the sensor or magnet, typical life expectancy is improved compared to traditional electromechanical switches. Additionally, the sensor and magnet may be encapsulated in an appropriate protective material. This application is used in [brushless DC motors](http://en.wikipedia.org/wiki/Brushless_DC_electric_motor).

**Automotive ignition and fuel injection**[[edit](http://en.wikipedia.org/w/index.php?title=Hall_effect&action=edit&section=19)]

Commonly used in distributors for ignition timing (and in some types of crank and camshaft position sensors for injection pulse timing, speed sensing, etc.) the Hall effect sensor is used as a direct replacement for the mechanical breaker points used in earlier automotive applications. Its use as an ignition timing device in various distributor types is as follows. A stationary permanent magnet and semiconductor Hall effect chip are mounted next to each other separated by an air gap, forming the Hall effect sensor. A metal rotor consisting of windows and tabs is mounted to a shaft and arranged so that during shaft rotation, the windows and tabs pass through the air gap between the permanent magnet and semiconductor Hall chip. This effectively shields and exposes the Hall chip to the permanent magnet's field respective to whether a tab or window is passing though the Hall sensor. For ignition timing purposes, the metal rotor will have a number of equal-sized tabs and windows matching the number of engine cylinders. This produces a uniform square wave output since the on/off (shielding and exposure) time is equal. This signal is used by the engine computer or ECU to control ignition timing. Many automotive Hall effect sensors have a built-in internal NPN transistor with an [open collector](http://en.wikipedia.org/wiki/Open_collector) and grounded emitter, meaning that rather than a voltage being produced at the Hall sensor signal output wire, the transistor is turned on providing a circuit to ground through the signal output wire.

**Wheel rotation sensing**[[edit](http://en.wikipedia.org/w/index.php?title=Hall_effect&action=edit&section=20)]

The sensing of wheel rotation is especially useful in [anti-lock braking systems](http://en.wikipedia.org/wiki/Anti-lock_braking_system). The principles of such systems have been extended and refined to offer more than anti-skid functions, now providing extended vehicle [handling](http://en.wikipedia.org/wiki/Automobile_handling) enhancements.

**Electric motor control**[[edit](http://en.wikipedia.org/w/index.php?title=Hall_effect&action=edit&section=21)]

Some types of [brushless DC electric motors](http://en.wikipedia.org/wiki/Brushless_DC_electric_motor) use Hall effect sensors to detect the position of the rotor and feed that information to the motor controller. This allows for more precise motor control

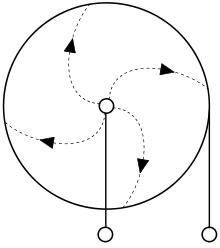
**Industrial applications**[[edit](http://en.wikipedia.org/w/index.php?title=Hall_effect&action=edit&section=22)]

Applications for Hall Effect sensing have also expanded to industrial applications, which now use Hall Effect [joysticks](http://en.wikipedia.org/wiki/Joystick#Industrial_applications) to control hydraulic valves, replacing the traditional mechanical levers with contactless sensing. Such applications include mining trucks, backhoe loaders, cranes, diggers, scissor lifts, etc.

**Spacecraft propulsion**[[edit](http://en.wikipedia.org/w/index.php?title=Hall_effect&action=edit&section=23)]

A [Hall effect thruster](http://en.wikipedia.org/wiki/Hall_effect_thruster) (HET) is a relatively low power device that is used to propel some [spacecraft](http://en.wikipedia.org/wiki/Spacecraft), after it gets into [orbit](http://en.wikipedia.org/wiki/Orbit) or farther out into space. In the HET, [atoms](http://en.wikipedia.org/wiki/Atom) are [ionized](http://en.wikipedia.org/wiki/Ionization)and accelerated by an [electric field](http://en.wikipedia.org/wiki/Electric_field). A radial magnetic field established by magnets on the thruster is used to trap [electrons](http://en.wikipedia.org/wiki/Electron) which then orbit and create an [electric field](http://en.wikipedia.org/wiki/Electric_field) due to the Hall effect. A large potential is established between the end of the thruster where neutral propellant is fed, and the part where electrons are produced; so, electrons trapped in the magnetic field cannot drop to the lower potential. They are thus extremely energetic, which means that they can ionize neutral atoms. Neutral propellant is pumped into the chamber and is ionized by the trapped electrons. Positive ions and electrons are then ejected from the thruster as a quasineutral [plasma](http://en.wikipedia.org/wiki/Plasma_(physics)), creating thrust.

The Corbino effect[[edit](http://en.wikipedia.org/w/index.php?title=Hall_effect&action=edit&section=24)]

[](http://en.wikipedia.org/wiki/File:Corbino_disc_by_Zureks.svg)

Corbino disc – dashed curves represent [logarithmic spiral](http://en.wikipedia.org/wiki/Logarithmic_spiral) paths of deflected electrons

The [Corbino](http://en.wikipedia.org/wiki/Orso_Mario_Corbino) effect is a phenomenon involving the Hall effect, but a disc-shaped metal sample is used in place of a rectangular one. Because of its shape the Corbino disc allows the observation of Hall effect–based [magnetoresistance](http://en.wikipedia.org/wiki/Magnetoresistance) without the associated Hall voltage.

A radial current through a circular disc, subjected to a magnetic field perpendicular to the plane of the disc, produces a "circular" current through the disc.[[10]](http://en.wikipedia.org/wiki/Hall_effect#cite_note-Adams1915-10)

The absence of the free transverse boundaries renders the interpretation of the Corbino effect simpler than that of the Hall effect.