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# NEW THEORIES https://newtheories.info

1. On electromagnetism
2. On light and colors



## ON ELECTROMAGNETISM

The Cosmos, nature and life, which in fact are a unity, are built on principles. Hierarchically seen, the principles stand above the natural laws. The latter are consequences of the former; or, we could say that natural laws are projections of the principles. In various natural laws we can find the same principles. If man manages to apprehend and learn the latter, he will establish a solid foundation to serve as a reliable compass for his contemplation and understanding of nature, but also of himself as an inseparable part of it.

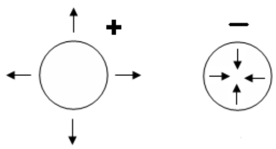
Contemporary science, despite its allegedly great achievements, has failed to perceive any of the important principles in the nature; hence, its chaos, incoherence, untruthfulness. Regardless of the praise and glory assigned to it by certain mass media, if one honestly asks oneself, one can hardly deny the impression that science, instead of making nature closer and more understandable, makes it more distant and incomprehensible.

This paper will begin with a presentation of a very important principle to immediately address what we have stated above.

We all breathe. Animals breathe too, and plants also breathe in some way. What is breathing? An initial observation could tell us that breathing is a constant expansion and reduction - a pulsation: when we inhale, our chests expand; when we exhale, they reduce in size.

The first two arithmetic operations a child learns in mathematics are addition and subtraction. If we add two to five, in reality it may mean that something that fills five volume units now expands by two and fills seven units. In turn, subtracting two out of seven means that seven contracts by two units and then fills five volume units. Therefore, we can label the expansion with the sign '+' and the contraction with the sign '–'. In this way, the act of inhaling we evaluate with plus, the act of exhaling with minus. In mathematics we can play through various computational tasks that often have nothing in common with our real world; but, if we want to stand on the ground of physical reality, we have to say that for each plus, a minus have to simultaneously arise somewhere. When we inhale, it means a plus in our chest at the expense of the surrounding atmosphere, which suffers a minus. This can be seen more clearly when we are inflating a balloon. The balloon is expanding – it means a plus arises within; but, at the same time, our chest is reducing - there is a minus in it. Let us take another example. A vacuum cleaner performs suction (–), but at the same time there is a vent on its plastic covering through which the air goes out (+). With a hair dryer we have the reverse.

Both the vacuum cleaner and the hair dryer are actually propellers (fans). The observer who stands in front of a fan will say that it blows, i.e. it exerts pressure (plus action), while the observer standing behind the fan will say that it suctions, i.e. it exerts depressure (minus action). In general, we could say that the plus denotes an action outwards, the minus denotes an action inwards (figure below).




Let us now consider a fan with only two blades. If the blades are completely flat, then, when the fan is turning, they will only cut the air like knives and there will be neither blowing nor suctioning. For this fan to function, it is necessary to twist the blades to a certain degree in the following way:

When this electrically driven fan, whose blades are twisted to the left, begins to turn to the right, then standing in front of it we will feel pressure, i.e. that it blows us (+); while, when it turns to the left, we will feel depressure, i.e. that it suctions us (–). If we twist the blades in the contrary direction (to the right), then at the turning of the fan to the right, we feel depressure (–), while at its turning to the left we feel pressure (+), or the reverse of the previous case[1].

Regarding the twist of the blades, the reader should think of wringing out a wet towel. If the right hand turns to the right, then we say the towel is twisted to the right; if it turns to the left, the towel is twisted to the left. The same applies to the fan blades.

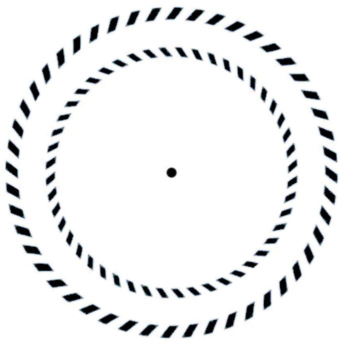
If we are to predict whether a fan will blow or suction if it starts turning to the right, first we need to look at the twist of the blades. If the blades are twisted to the left, i.e. like this '/' (fan blade viewed from above), then, when this blade turns to the right, it attacks the air first with its 'upper' part. Higher air pressure forms in front of this part than in front of the 'lower' part, so the air moves towards us, i.e. we are blown. What is important here to us for that what follows is to pay attention to the fact, that the blades of a fan (if it is a multi-bladed) which at a given moment are up blow us more on our left side, and those which at the same moment are down blow us more on our right side; that is, the flux is whirled rather than linear (flux ≈ flow).

We see that for an observer, whose position remains unchanged (i.e. standing in front of the fan the whole time), the following four cases may occur:

| The blades are twisted to the | The fan turns to the left | The fan turns to the right |
|---|---|---|
| left | – | + |
| right | + | – |

[1] The texts in frames should be footnotes, but since they are often pretty long, the author decided to put them in frames.

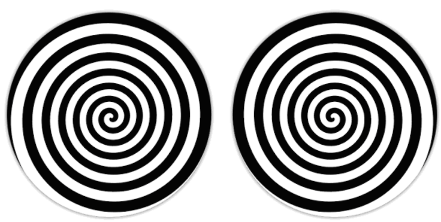
Look at the broken circles on the figure below. As you move the book closer and then farther away from you, looking constantly at the central point of the circles; or, if you place the book on a table, then lower and raise your head still looking at the central point (in this case the effect is stronger) - it seems as if the circles are turning in one direction upon coming closer, but in the contrary direction upon moving away. The experiment can also be carried out with only one circle. The dashes of the outer circle are 'twisted' to the left, those of the inner circle to the right. Upon moving the head closer, the outer circle turns to the left, the inner one to the right. When moving away, the opposite occurs. What does the movement away mean? It means nothing other than that the circle is 'blowing' at us, just as with the approaching of the head the circle draws us in. We see that we have here exactly the same conditions as in the previous case of the fans, so that the table above is valid here too.



The outer circle corresponds to the fan described in the text box above. When we move our head away, i.e., when it 'blows' at us, then it turns to the right.

The turning effect comes about only if the circles' dashes are somewhat slanted.

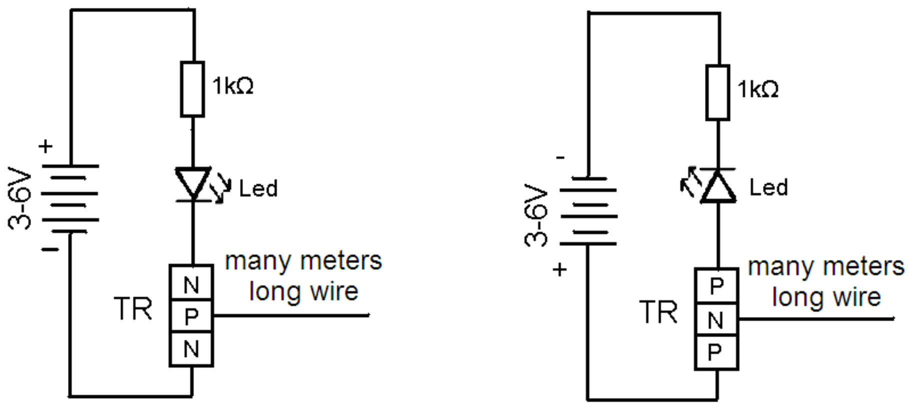
Let's consider these two spirals:



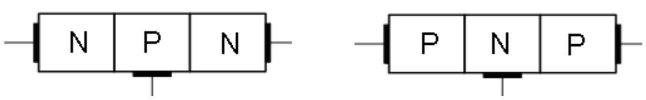
They differ only therein, that the first turns to the left (observing the black line from the center outwards), while the second to the right. If we make holes in the centers of the spirals, place them on spinning tops and turn the first one to the right looking unremittingly at it as it rotates, then we have the feeling as if it exerts pressure on us, i.e., as if it were pushing us (+), whereas when turning it to the left, we have the feeling as if it exerts depressure on us, i.e., as if it were pulling us in (–). With the second spiral occurs the same but in reverse order. We see that for an observer arise the same four cases from the previous table. (The spiral line turns to the left, the spinner turns to the right - then the spiral pushes us (+). This case corresponds to the fan's case described in the frame above. The same occurs with a screw or a household meat grinder. The thread of the screw turns to the left, and as the screw is turned to the right, it penetrates (+) into the wood.)

Let's go back to the fan again. Instead of an internal drive setting it in motion, it can also be turned by an outside force, as is the case with windmills. To see what happens here, we will make a simulation with a small fan (like those in computers), a hairdryer and a vacuum cleaner. If we bring an operating hair dryer close to the fan, it starts turning in one direction, and upon bringing an operating vacuum cleaner, it rotates in the contrary direction. The reverse happens if the fan blades are twisted in the contrary direction. There are four cases also here, two pluses and two minuses.

Everyone knows that something called ‘plus’ and ‘minus’ exists in both electricity and magnetism. We have all seen that ordinary 1.5V batteries have the mark (+) at the nipple and the mark (–) at the flat end. In magnetism, the two poles are called north and south, but they can be rightly called plus and minus. Which pole is here plus and which minus, we will see later. Do these plus and minus poles of electricity and magnetism show properties reminiscent of those we have just seen? To test this, we will carry out some experiments. Therefore we need two simple, almost identical electrical circuits, each with a battery, a resistor, an LED lamp and a transistor (figure below).




The circuits are independent of each other and do not differ absolutely in anything other than in polarity. What that means will be clear in a moment. The lamp serves as an indicator. When it lights up, it means that current is flowing through the circuit. The resistor (300Ω - 1kΩ) is solely in the service of the lamp, to prevent a stronger current causing damage. What remains is to briefly explain the element called transistor. Unlike the majority of elements in electrical technology that have two ends, i.e. two leads, this element has three ends, because internally it consists of three segments (figure below).

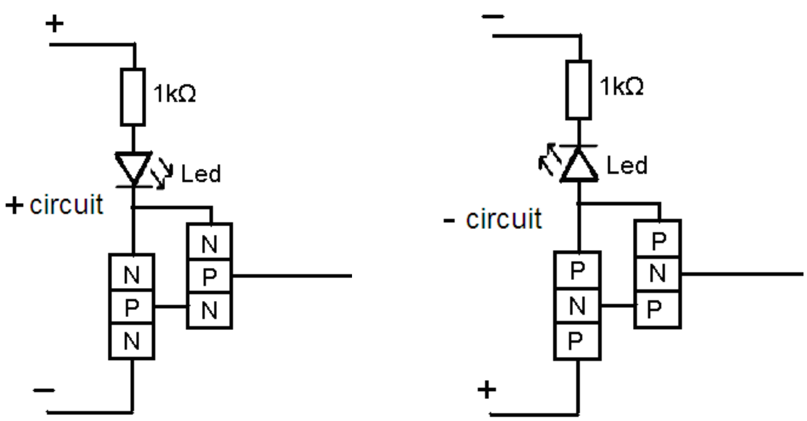



About the transistor we will now figuratively say only what we need for the experiments, but will explain more later. What matters most to us at the moment is its middle segment, which we will temporarily call a heart of the transistor. In the drawing we can see that the left transistor has a plus-heart (we call it + transistor), while the right one has a minus-heart (– transistor). We also see that the heart is a kind of bridge between the other two segments. In order to make the (+)transistor work, its heart should be actuated by (+)electricity. Thereby the bridge is established. If the heart is acted upon by (–)electricity, then it behaves indifferently. The reverse applies for the (–)transistor.

The lead from the heart we lengthen with a metal wire that is several or even many meters long, thus its end will be far from the circuit itself. Therefore we will be absolutely sure that the influence we are going to exert on the end of the wire affects only it and not any other element in the circuit. The end of the wire is loose, that is, not connected to anything.

However, in order to check what we have just said, that the (+)heart reacts only to plus-electricity, whereas the (–)heart to minus-electricity, we may hold the loose end of the wire with one hand and with the other hand first touch the (+)pole of the battery and then the (–)pole. We will see that the lamp lights up only in one of the two cases: in the (+)circuit [the circuit with the (+)transistor we will call (+)circuit] the lamp lights up only when we touch the (+)pole of its battery; and in the (–)circuit it lights up only when we touch the (–)pole of its battery. It is not advisable to connect the end of the wire directly to the (+)pole of the battery in the first case and to the (–)pole in the second for reason explained later in this paper.

What will be described now as an experiment can be done with these circuits' set-ups; however, for their greater sensitivity, in each of them we will add one more transistor [two (+)transistors in the first and two (–)transistors in the second circuit (figure below)]. It doesn't change anything except that we will save on effort needed to do the experiment, i.e., with less effort we will achieve a greater effect. If we still work with only one transistor per circuit the effect will be weaker, but it can be somewhat intensified if we attach the loose end of the wire to a wide metal plate - let's say a pot lid - and if we reduce the resistor's value to 100-200Ω.




Once the two circuits are ready, we take a vinyl gramophone record, a thin-walled glass, and a piece of woolen and silk fabric. We rub the vinyl plate with the woollen cloth and bring it close to the loose end of the wire of the (–)circuit. We will see that the LED will light up. It will also light up if we bring it close to the wire's loose end of the (+)circuit. But if we play a little bit, we will notice that there is a fundamental difference between the two cases: the LED in the (–)circuit lights up when we move the vinyl plate towards the wire, and the LED in the (+)circuit lights up when we move the plate away from the wire. Now, if we take the glass, rub it with the silk (or woollen) cloth, we will notice that the reverse happens: the LED in the (–)circuit lights up when we move the glass away from the wire, and the LED in the (+)circuit lights up when we move it towards the wire. If we don't move the electrified objects, absolutely nothing happens. As mentioned before, this is quite feasible with only one transistor per circuit, yet the movements of the vinyl plate and the glass have to be much more energetic. But even in this experiment with two transistors per circuit we can notice that the faster we move the electrified objects, the stronger the lamps light up.

The cloths after the rubbing produce the reverse effect from the rubbed objects. Still, their effect dies out much faster than that of the vinyl plate and the glass.

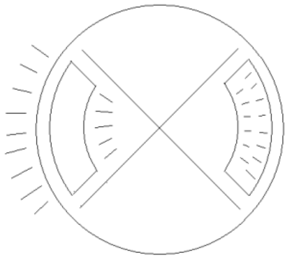
From this it becomes clear that vinyl and glass act completely opposite: vinyl stimulates the minus transistor by moving towards, and glass by moving away from the wire end; vinyl stimulates the plus transistor by moving away from the wire end, glass by moving towards it. We see that there are four cases here as well:

| | towards | away |
|---|---|---|
| Glass | + | – |
| Vinyl | – | + |

Let’s carry out another experiment with these two circuits. We take a long isolated wire, wind it around a cylindrical object and then remove it, thereby obtaining a spiral-shaped wire. We connect one end of it to the two loose ends of the wires leading to the transistors of the (+) and (–)circuits (here, as before, we can do the experiment with only one circuit at a time). The other end of the spiral wire remains loose. Now we take a strong cylindrical neodymium magnet and quickly insert it, keep it inside, then quickly pull it out of the spiral. We notice that one lamp lights up upon inserting the magnet, while the other lights up upon pulling it out. As long as the magnet remains in the spiral, nothing happens. Then if we turn the magnet, insert it and pull it out with its opposite end ahead, the lamps light up in reverse order. They light up more strongly if the magnet is inserted and pulled out faster, if the spiral has more windings, if the magnet is larger and stronger, and if its diameter is not much smaller than that of the spiral. For this experiment to be carried out successfully as described here, we need a very strong magnet, many windings and very quick insertion and removal from the spiral. If these conditions are not fully met, then we don’t leave one end of the spiral loose; instead, we connect it to the (–)pole of the battery in the (+)circuit, and to the (+)pole of the battery in the (–)circuit; thereby the experiment is carried out much more easily. We see that there are four cases also here.

That the positive electricity has the nature of expansion (blowing, pressure, explosion) and the negative electricity the nature of contraction (suction, depressure, implosion) can also be seen with naked eye. There is namely a whole group of so-called electrostatic generators, also called influence machines, similar but somewhat different from each other: Voss-, Toepler-, Holtz-, Bonetti-, and the most popular and widespread, the Wimshurst-machine. Since this machine is available to us, we will briefly describe it. The basic elements of this generator are two very close (about 5 mm), vertically placed glass or plastic circular plates (discs), metallic sectors of aluminum foil glued on the discs and two metal rods placed in the shape of the letter X, but one in front of the front disc (\), and the other behind the rear disc (/). Although the rods are on different sides, we will say that their X-shaped placement divides the discs into quarters, which we will call quadrants. We term the left and the right one horizontal quadrants, the upper and lower one vertical quadrants. The metal rods, which have the shape of the square bracket “]”, end with metal brushes that gently scratch the plates (including the metallic sectors) when the discs rotate. They rotate in contrary directions; this is achieved so that during the manual rotation of the crank, the movement is conveyed by two belts, one of which (for the front disc) is in the form of the letter O, and the other (for the rear disc) is twisted in the shape of number 8. Electricity is generated solely by these elements. Therefore we consider the other parts of the machine as inessential. They are necessary only if we want to produce sparks from the already generated electricity; so, to prevent them from bothering us, we can even remove them. We will consider them later.

If we begin to rotate the discs by turning the crank to the right in a dark room (the most noticeable results can be seen at night in a room with a little exterior street light entering it), and if we do this for at least 10-15 seconds to let the eyes get used to the feeble light, we will notice that the horizontal quadrants emit a light flicker, whereas the vertical are completely dark. On turning the crank to the left the flicker relocates to the vertical quadrants, whereas the horizontal ones now remain dark. Looking even more attentively at the scene, we will notice *an essential qualitative difference* between what happens in the left and the right quadrant (i.e. the upper and the lower one when the crank is turned to the left). The flicker in one horizontal quadrant is directed from the metal sectors outwards, in the other one inwards. In other words, in the left quadrant *the metal sectors are dark* and the flickering light glows around them, but in the right quadrant *the metal sectors are illuminated* and around them it is dark (image below).



The sectors in the image are drawn as a whole, and not individually, because the light phenomenon appears as a whole; more precisely, as two wholes, one left and one right, and not individually in the sectors. We consider this as an ultimate proof of the essential difference between the plus and the minus of the electricity. We say that a proof is ultimate or final when we directly perceive the truth with our senses.

Without turning the generator, we move the wire of the (+)circuit with its loose end towards, and then away from one horizontal quadrant; then we do the same with the other quadrant. We can do also the reverse: move the generator with its left or right quadrant towards and away from the wire (as we did with the vinyl plate and the glass), which is basically the same. With the left quadrant, where the flicker was directed outwards, the lamp lights up only when the wire moves towards it; with the right quadrant the lamp lights up only when the wire moves away from it. If we do the same with the wire of the (–)circuit, then the reverse happens. We see that the (+)quadrant behaves like the glass, while the (–)quadrant like the vinyl plate.

Observing the described phenomena in the dark, we find that we don't actually need any detector to determine on which side is the plus-, and on which side the minus-electricity.

Whether the plus will appear in the left, and the minus in the right quadrant, or the reverse will happen, is left to chance. The plus and the minus may occasionally change sides.

From the history of electromagnetism it is known that Benjamin Franklin (1705-1790) is the man who was the first to introduce the terms "positive" and "negative", i.e. "plus/minus" in the field of electricity in the middle of the 18th century. Previously, the different types of electricity had been called "vitreous" (meaning "glass") and "resinous" (meaning "amber"), since the glass and the amber were the most often rubbed objects to produce the opposite electricities. At the time when Franklin gave his contribution, people had actually spoken of two types of electric fluids; however, Franklin argued that there is only one electric fluid, and the excess and the shortage of it in the objects he called "plus" and "minus". He said that bodies in normal condition have medium amounts of this fluid and are therefore neutral. When two objects are rubbed against each other, one allegedly transfers a part of its fluid to the other and thus the first becomes minus-, and the second object plus-electrified.

It remains a mystery how this type of thinking resulted in the glass electricity being called "plus", and the amber electricity "minus", although it has been recorded that Franklin is the man who assigned the plus to the glass, and the minus to the amber electricity. Still, this cannot be confirmed. In fact, on the basis of this kind of thinking (i.e., in the sense of "excess" and "shortage") it is impossible to reach a solution, which electricity is plus, and which minus.

Back then, as well as now, it is still considered to be arbitrary, a matter of convention; therefore it is said that there are no obstacles in naming the electricities the other way round. There exist even such opinions that this de facto should have been the reverse, because the convention is that the electric current through the wire flows from the plus to the minus pole (conventional current), while the electrons, which "appeared" almost one and a half century later and are allegedly the carriers of the electric current, were negatively charged and consequently moving in the contrary direction (electron current), so that with the reversed designation the irreconcilable contradiction, which has since set in motion an "eternal" discussion, would have been avoided. From what we have presented so far, but also from what we are going to expound further, it becomes clear that the polarity of electricities is well chosen and there is no need to change it.

If we look at an image of a magnet with its lines of force in any textbook, we will notice that the directional arrows point outwards at its north (N→) and inwards at its south pole (S←). This should mean that the north pole is the positive, the south pole is the negative. And here, too, it is said in science that it is arbitrary. But since this in no way can be arbitrary, it remains to determine which magnetic pole is actually plus and which minus.

First, let's clarify what is magnetic north pole and what is magnetic south pole. Since we need a compass for that, let us briefly explain what kind of instrument that is. The Earth is a giant magnet with two poles, North and South. They do not quite coincide, but are pretty near to the Earth's geographic poles. Each magnet, separated from the Earth and free to move, strives to align itself with the giant magnet. To illustrate this, we take a bar magnet and place it on a flat piece of styrofoam. Then we let the styrofoam with the magnet float in a water tank. We will see that however we place it on the water surface, the styrofoam always turns so that the magnet has a strictly fixed direction. If we check the direction, we will find that it is north-south. But not only that. If we mark the styrofoam at one end of the magnet with a red dot, and at the other end with a blue dot, we will see that, in addition to the strict direction, the orientation is also strictly determined: the red and blue ends always place themselves in the same position - one color dot always points north, the other south. Our magnet can only move in a horizontal plane. If it can move in a three-dimensional space, we would see that it is positioning itself in a north-south direction, always tilting at a certain angle to the earth's surface, lowered northwards and raised in the south (this is referred to as the angle of inclination). This we can prove again in our water tank. We take a ball of styrofoam, insert a non-magnetized sewing needle through the center and place the styrofoam ball in water; if the needle does not tend toward to one side, this means that its center of gravity is exactly in the center of the ball. Next, without removing the needle from the ball, we magnetize the needle by touching it with a magnet. When we place the ball back in the water, we notice that the needle except that it turns to where it is in north-south direction, it also dips to the north (that is, it is pointing in our direction if we are facing north). This angle is approximately 45-50° in our latitude. It shows that the needle wants to unite with the magnetic north pole, because it is closer. The further north we go, the greater the angle. It is 90° at the magnetic north pole (the magnetic needle is erected vertically), but at the equator the angle is 0°. We see that the pole of the compass facing north is actually its south pole.

In order to determine which magnetic pole is plus, which minus, the author tried to detect some difference in the jagged shape which tiny iron filings create when they adhere to the north and south pole of the magnet. There seemed to be a difference therein, that at the one pole the spikes looked as if they were single-spiked, and at the other pole they appeared double-triple spiked, similar to the anterior and posterior part of the arrow shape. But it was so unclear and uncertain that one could not rely on it at all. The undoubted result came when the author once played with a ring magnet from a loudspeaker and accidentally came up with the thought of filling the middle of the ring with the iron powder. The poles of the ring magnet are its two flat surfaces. Once its middle was filled with the iron powder and then it was tapped to allow the powder to freely take its shape, the difference between the one and the other side became clearly visible. At the north pole a form of suction was evident, and at the south pole a form of blowing. Hence, the plus pole with an action outwards is the magnetic south pole of the Earth, and the minus pole with an action inwards is the magnetic north pole of the Earth.

The convention in force today is that the pole of the compass pointing north is called the north pole. Hence, the Earth's magnetic pole close to the Geographic North Pole is called the Magnetic South Pole of the Earth, and the one close to the Geographic South Pole is called the Magnetic North Pole. In this work, contrary to the convention, we name the pole of the compass facing north its south pole.

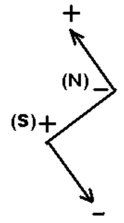
All the confusion actually disappears if the magnetic poles are simply called "plus" and "minus". The pole of the compass facing north is the plus magnetic pole. The compasses, whose needles have an arrow shape, give a very good picture of this because we term the front part of the arrow, which faces north, "plus", and the back part, "minus". (− >—> +)

The front part of the arrow we consider as plus, the back as minus. The front part penetrates and exerts pressure, and the rear suctions, exerts depressure. This can be seen in the shape of the front and the back part of the arrow itself. It is the same with vehicles. Some cyclists risk their lives by driving directly behind large trucks to take advantage of the depressure in the slipstream and reach speeds up to 90-100 km/h on level roads. In videos that can be seen on Youtube, it seems like they are turning the pedals in a void, as if the truck pulls them, although they do not hold onto it.

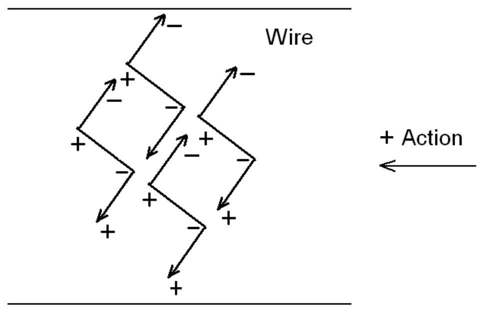
We will now introduce a theory which explains what happens in the wire leading to the heart of the transistor, as well as in every current-carrying wire. (At this moment, only on the basis of what has been so far presented, this may appear too early; in what follows, however, we will see other experiments and phenomena that contribute to the theory.) We call this theory "dynamistic" because it speaks of forces (δύναμις = force), in contrast to the current theory, which we call "materialistic" because it speaks of material particles, called electrons, supposedly moving through the metal wires. We call the theory dynamistic because in its basis lies *vibration of electromagnetic forces* (EM-forces). These forces are not of material nature. What was just said is well documented when we recall that the magnetic and the electric forces cannot be blocked by material bodies that are placed between the source of the force and the bodies they act on. For example, if we put a piece of iron near a magnet, the magnet will attract it even if we place a plastic, wooden or metal board between them. Likewise, radio waves penetrate walls without perforating them. This can be done only by something that is not of material nature. But even though they are immaterial, a material body is needed as their source. And in order to manifest themselves, they also need a suitable object to act upon; otherwise we would not be aware of their existence. Actually this is also the case with many other things in life. For example, the painter's abilities are immaterial, but a suitable physical body is necessary as their source. It can be only a human, not a monkey and not a wolf. Still, for these abilities to manifest themselves, they need a material body to act upon, and that is the artist's canvas.

Other terms necessary to understand the theory are "order" and "orientation". We can get a notion of these terms from several things: from magnetism, thread, wood, etc. When a magnet is brought in the vicinity of iron powder, the particles will adhere to the magnet with strictly *oriented order*. If we think of such a particle as a very small line segment, then it aligns itself not only in the same direction with the other particles, but also has a strict orientation of its plus and minus poles. We can imagine the particle as the smallest possible line segment and yet its properties will remain as described. In the thread we also have an *ordered* multiplicity of tiny little plant or animal fibers in the same spiral direction, except that there is no orientation here, that is, the fibers have no poles.

Now we introduce the electromagnetic force element, which is the basis of this theory. We put it this way:

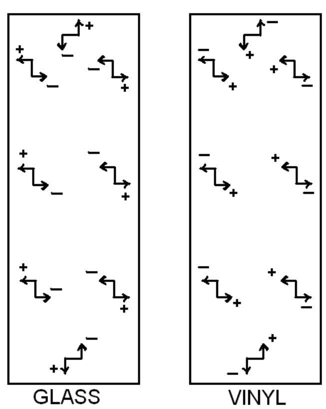


It has three segments. In the middle is the magnetic segment with its two poles, S(+) and N(–), and at its ends the electrical plus and minus segments, arranged at an angle of 90° to the magnetic segment. We have to imagine these elements in a huge multiplicity, evoked[2] by the movements of the aforementioned objects (vinyl, glass, magnet) and at the same time ordered according to a strict orientation of their electric and magnetic segments. ( Figure below)




When there is no movement of the electrified objects towards or away from the wire, we cannot say that these elemental forces are still present in the wire only being chaotically distributed; rather, we should simply say that they are not there, or, to put it more correctly: they are latent. Here we can draw a parallel to the human. If we are offended, it can cause anger in us. Should we then say that the anger constantly exists in us but is, so to speak, only chaotically distributed throughout the body and therefore has no power, and at the moment of offense the chaos get ordered or concentrated and thus develops power? The author thinks that cannot be said. And as the anger of immaterial nature is, so is the hurtful word that has evoked it; for their manifestation, however, material bodies are necessary.

These forces appear not only in the wire, but also in the objects (vinyl and glass) that we rubbed with the woolen cloth. Their electrification can be represented as follows:




The plus segments of the elemental EM-forces in the glass are directed outwards from the object, the minus segments towards the interior of it, and therefore have no external effect. With the vinyl, it is the other way round.

When we move the plus-electrified object towards the wire, its plus segments evoke the elemental EM-forces in the wire and at the same time arrange them in a *spirally whirled form*, doing this *<u>by acting on their plus segments.</u>* The ordered direction of the plus segments in the wire is the same as the direction of

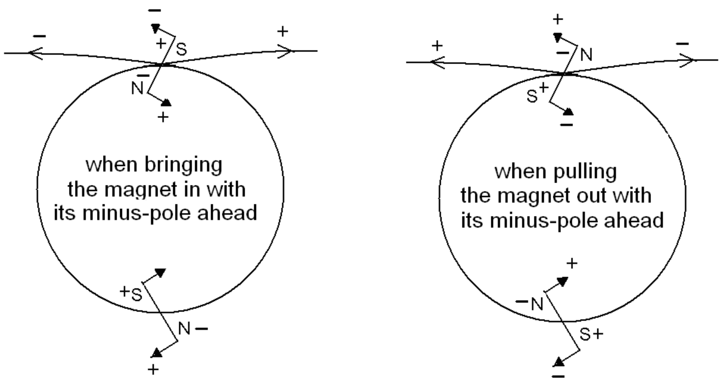
[2] For what we call here 'evoke' or 'provoke', in the current theory is used the Latin verb 'inducere', which means "bring in, lead in, introduce". From the explanations in this work, the reader will understand why we use the verbs 'evoke' or 'provoke'. In Latin, they are 'evocare', 'provocare'.

motion of the plus-electrified object. Like a gust of wind this effect propagates in a domino effect through the entire length of the wire. Hence, the plus segments of the EM-forces in the wire are oriented to the heart of the transistor, and if it is a plus heart, the lamp lights up. When we move the plus-electrified object away from the wire, it again evokes with its plus segments the EM-forces in the wire *by acting on the same-named segments*. Because this time the motion is in the opposite direction, the plus segments in the wire are oriented outwardly from its free end. This at the same time means that the minus-segments of the EM-forces are oriented towards the heart of the transistor. If this is a minus heart, then the lamp lights up. The aforesaid also applies to the processes with the movements of the minus-electrified object, only in this case the effects are reversed.

To explain what happens when we insert the magnet into or pull it out of the wire spiral, first we will present the following experiment. Through a thick copper or aluminum tube held vertically we drop a strong cylindrical magnet. We notice that the magnet in the tube falls much slower than out of it. We conclude that in the metal of the tube are evoked the EM-forces whose magnetic segments are so directed that they delay the fall of the magnet. This delay happens from two sides. While the magnet is falling in the tube, its lower end at every moment enters the remaining portion of the tube, and at the same time its upper end leaves the already traversed section. Both the one and the other effect must be slowing down the fall of the magnet; for, if the one slows it down and the other accelerates it, then these two effects would cancel each other out and the magnet would fall with the normal speed. Thus, when the magnet falls down with its minus pole ahead, in the part of the tube which is lower down it evokes the EM-forces whose magnetic segments are oriented with their minus poles upwards, therefore repelling the magnet (i.e. slowing it down); but, in the part of the tube that is higher up than the magnet (where its plus pole is), the EM-forces are evoked in the metal with their minus-poles of the magnetic segments oriented downwards, therefore attracting the magnet (i.e. slowing it down too).

That being said, we return now to the experiment with the spiral wire (which is a kind of a tube) and we can say that the insertion of the magnet into the spiral evokes the EM-forces in the wire *by acting on their magnetic segments*, which align themselves so that they try to prevent the entrance of the magnet; and that its pulling out evokes the EM-forces, which align themselves so that they try to prevent this, too. But the wire of our spiral is insulated with transparent lacquer, so the metal of the windings cannot touch directly; therefore, the magnetic and electric segments of the elemental forces in the spiral wire are not arranged so to form closed toroidal fluxes below the lower and above the upper end of the magnet (as we can describe the case of the copper tube), but they string together throughout the entire length of the spiral and continue onwards through the straight part of the wire. In other words, the magnetic spiral wind spreads through the entire path of the conductor. The insertion of the magnet with its minus-pole ahead will evoke the EM-forces with their minus-poles oriented outwards of the spiral, however, not at right angles with respect to the wire, but in the upper part pointing to our left, and in the lower part to our right side (thus, in the left part downwards and in the right part upwards)[3]. (Figure below)

[3] This direction of the EM-forces does not result from some properties of the wire metal, but from the inherent direction of the magnet's spin. We have here something similar to the push-and-spin mechanisms that we see in small toy carousels, in appropriately designed ashtrays, or spinning top toys.
From where we draw the conclusion about the orientation of the magnetic segments in the upper part of the spiral to our left, and not right side, we will see later when we present other experiments.




This again means that the (+)E-segments will be directed to the right, and if the right end of the spiral (*the ends facing upwards*) goes into the plus and minus hearts of the plus and minus transistors, then the lamp in the plus-circuit lights up. Pulling the magnet out of the spiral will evoke the EM-forces with their (+)magnetic poles facing outwards, therefore the (–)E-segments will be directed to the right, so that the lamp in the minus-circuit lights up. If we now insert and pull out the magnet with its (+)pole ahead, the lamps light up in reverse order.

We can make a similar experiment with an analog or a digital am(pere)meter, but the result with an analog is more impressive. We connect the right end of the spiral to the red (+)input of the ammeter, the left end to the black (–)input. We place the range selector at the highest sensitivity position (mA or μA). The insertion of the magnet with its minus-pole ahead will cause a positive deflection of the pointer (i.e. to the right), while pulling the magnet out will cause a negative deflection (to the left). The same experiment made with a digital ammeter will show a minus sign in front of the digits upon pulling of the magnet out.

What we evoke in the wire with the oscillating movements of the vinyl plate, the glass and the magnet is nothing other than alternating current. But it can also be said that we produce what in digital electronics is called one (1) and zero (0). As we will see later, when the plus electricity is directed to the hearts of the transistors, it is a digital “1”, when the negative electricity is directed that way, it is a digital “0”. Or briefly: the (+)electricity is 1, the (–)electricity is 0.

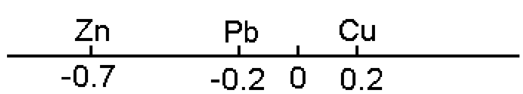
Let us say something about the battery as a source of electric current. We can regard it as a container of dissolved agent (acid, base or salt) wherein two plates of different metals are partly immersed. Instead of one of the metal plates can also serve a graphite rod. As there is an exception to every rule, so it is in the electromagnetism. Coal is a special and unique case of a non-metal that is a conductor of electricity. Consequently, it is also a good electrode in a battery[4]. As the electricity was previously produced by rubbing a woolen cloth against vinyl or glass, so it also arises here through friction between the agent and the metal surface. The difference is that in the first case there was a mechanical, whereas here it is a chemical friction. But since two dry materials cannot rub chemically, the battery jar must contain water. In the first case everything had to be dry, in this case everything has to be well wet. Another difference is in the order of the EM-forces. In the first case, the entire vinyl record was electrified negatively. The positive segments of the elemental forces are directed inwards and therefore have no effect outwards. But that they also exist in the vinyl shows the fact that it can be electrified positively, however not by mechanical friction, but by something called influence. If we near a negatively electrified vinyl plate to a non-electrified plate, the latter becomes positively electrified. However, this positive electrification of the

[4] According to the etymological meaning of the words, what we describe here should not be called a battery, but a cell (an electrochemical cell). Battery is a multi-cell set. For example, the car battery is exactly that - a multi-cell set.

vinyl plate loses its effect very soon because this type of electrification is not its innate. The same applies to the glass, but with opposite polarity. We can see that certain materials have an inherent tendency to plus (glass, leather, nylon), but others to minus (amber, vinyl, silicone, teflon, PVC). With metals that are partly submerged in a dissolved agent, both polarities manifest simultaneously. The part of the metal plate outside the liquid is polarized in one sense, the immersed part in the opposite sense. The two metal plates of the battery can be imagined as two fans. The one that blows outside the liquid (positive electrode), that suctions inside it; the one that suctions outside the liquid (negative electrode), that blows inside it. When the electrodes are connected with a wire, a closed flux is created, which will circulate until one of the plates is consumed or until the agent has transformed into something else and thus has lost its aggressiveness. These two processes are interconnected and take place simultaneously. In the agent there is movement of matter. For comparison and better understanding, we use another natural phenomenon, the waves in the oceans. The water level rises and falls and we cannot say that the water moves toward the coast with the speed of the wave. However, an object floating on the water will move with each wave a little onwards until it eventually reaches the coast.

It is similar with the trembling of the EM-forces, that is to say, with each tremble the matter moves slightly through the solution. At the same time the negative electrode wears off, which is understandable, because its part inside the solution behaves as positive and *the movement is always from the positive to the negative*. If we open a "dead" carbon-zinc battery, we will see that the zinc jar (the negative pole) is completely dissolved, while the carbon rod (the positive pole) in the middle is quite good. The electroplating is also a result of movement of the matter on the electric waves. The positive electrode of carbon arc lamp connected to DC consumes itself, whereas the negative electrode remains pretty intact. Above we have said that certain non-metals have the tendency to plus-, others to minus electricity. For metals we cannot speak in the same sense of the tendency to plus or minus, because, as we see, the two polarities manifest here simultaneously. However, if we speak of the polarity of the metal plate outside the liquid, we can say that gold, silver, copper, platinum and carbon* among others have inherent plus tendency, while zinc, lead, aluminum, tungsten, iron etc. have minus tendency.

Let us now consider the following experiment. We need three metal plates, a copper, zinc and a lead plate and a small container with vinegar. First, we dip the copper and the zinc plate partly in the vinegar and connect them to a voltmeter: the copper plate to the (+)input, the zinc plate to the (–)input of the instrument. A voltage of about +0.93 V is measured. Then we do the same with the other two possible combinations. In the combination of copper and lead plate we measure about +0.43V when the copper plate is connected to the (+)input of the instrument, and in the combination of lead and zinc plate about +0.50V when the lead plate goes to the (+)input. In all cases the copper plate behaves like a (+)pole, the zinc plate like a (–)pole, only the lead plate in one case behaves like (–), in the other like (+)pole. On the horizontal axis of a graph we mark copper with +0.2, lead with –0.2 and zinc with –0.7 and see that the difference between copper and lead is 0.4, between copper and zinc 0.9 and between lead and zinc is 0.5, which is nearly consistent with the results of the voltage measurements. Therefore, we conclude that copper has the tendency to plus, lead the tendency to minus and zinc has a strong tendency to minus.




In the third case of the experiment (Pb-Zn), we saw that the lead plate behaved as a (+)pole. Here a reversal of the polarity of the lead plate takes place. The strong minus of the zinc plate reverses the weak minus of the lead plate converting it into plus. Let's compare that to the fans. Two fans with electric drives, one strong, the other weak, both suction, are moved towards each other. The stronger will then force the weaker to turn in the contrary direction, i.e. to behave as (+)blowing force in the interspace. If the strength of the stronger is 0.7 units and that of the weaker 0.2 units, then the strength of the stronger will decrease by 0.2 units in the interspace because part of its force it uses to overcome the power of the weaker. In the case of copper and zinc, there is another configuration because their forces add up (0.2 – (–0.7) = 0.2 + 0.7 = 0.9).

A reversal of polarity is also seen on magnets: a strong neodymium magnet reverses the polarity of a small and weak Al-Ni-Ko magnet, but in this case the reversal is permanent.

If we connect the poles of a 1.5 volt carbon-zinc battery with a good conducting wire (so-called short circuit), then the battery voltage will fall rapidly, but will remain at a certain value considerably less than the initial. If we break the circuit, the voltage soon returns to the initial value. Connecting the battery poles with a wire of high resistance, the voltage of the battery will not fall. We can compare this to a container filled with water. If an outlet is located in the lower part of its lateral wall, the force with which the water flows out (determined by the reach of its jet) depends only on the height of the water level, which also represents the pressure on the outflow point. The container is not large and, as the water flows out, the water level and thus the pressure decreases, which reduces the jet reach. Let's imagine that the water column is quite high and that, as we open the outflow, a steady flow of water into the container begins; this inflow is smaller than the outflow of water in the first moments. As the water level drops, so does the intensity of the outflow, thereby at a certain moment the inflow and the outflow equalize and from then on the level but also the jet remain unchanged. Let us imagine another situation. Instead of a water container we have a huge lake with sufficient inflow and an outlet in the lower part. The force of the water jet with unchanged size of the outlet will always be the same; it is so because the water drain has no, or only a negligible effect on the level of the lake.

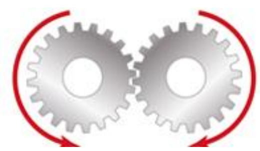
Let's get back to the battery. The fact that we cannot get more than 1V from copper, zinc and an acidic solution is a good example of the limitations that exist in the real physical world, and that must always be kept in mind if one doesn't want to lose touch with reality. Also, in our water example, we cannot construct a container that reaches sky-high even with the latest technology; the container will always have a limited height and at some point the water will overflow.

We compare the size of the outlet to the conductivity of the wire. The larger the outlet is, the greater the conductivity. The intensity of inflow into the container we compare with the friction intensity of the agent with the metal plates. If we make a battery with larger plates in a larger container, but also with a more aggressive agent (sulfuric acid, for example, is much more aggressive than vinegar), then we have more intensive friction (i.e. more intensive "inflow") and the voltage to which the initial voltage will fall when connecting the battery poles with a good conducting wire will be higher compared to the case with the smaller plates and the less aggressive acid.[5] Hence, the current will be stronger too. With a huge battery,

[5] The described battery filled with vinegar is unusable for practical purposes because the vinegar is a very weak agent, i.e. the "inflow" in the battery is very low. No matter which bulb we connect to this battery, its voltage will immediately drop to zero and the bulb will not light up. Nevertheless, this battery shows the same voltage on the voltmeter as the one with the more aggressive agent, such as sulfuric acid. The measuring of the battery voltage we can compare with the measuring of the pressure at the lateral bottom point of an opaque container whose water level is unknown. At this point, we pierce a fine hole with a very thin needle and determine the water level in the tank according to the jet reach. Before that, through experiments with foreknown water levels (i.e. pressure values) we had set a scale of the jet reach at the same pinhole. With this scale we can also determine the pressure in the opaque tank, i.e. the unknown level when we make a hole with the same needle. Since the jet is very thin, the outflow won't have a significant effect on the water level even of a very narrow tank. When we measure the voltage of a battery, we actually connect it to a great resistance (which we can think of as an extremely thin and long wire), measuring the strength of the current through it on the basis of the scale previously set. Although the bulb is also an extremely thin wire, its resistance is still low because of its shortness. Therefore, its connection to the vinegar battery is comparable to a larger hole in a narrow tank with water, in which there is also a very low inflow, resulting in the level falling immediately to zero.

the voltage will not drop at all (this is the case with the huge lake). To achieve a voltage greater than 1 volt, we need to connect two or more cells in series. So we can get higher voltages only in steps: 2, 3, 4 volts. The parallel connection of two cells (plus connected to plus, minus to minus) which deliver the same voltage is the same as if we would have increased the dimensions of the plates and the container of a single cell. Increasing the dimensions of a cell also affects its power output, inasmuch as with a larger cell a bulb will shine longer before it begins to dim. The unit of measurement for this value is called ampere-hour (Ah). If a battery has 10 amp-hours, it means that it can supply current of one amp for 10 hours. Of course, this is an ideal value, since the voltage and thus the current *gradually* drops, and so the luminosity. However, if the battery delivers half an amp for two hours, that's one ampere hour too.

When two gears mesh and move, then one turns in one direction and the other in the contrary direction.



A

B

Instead of the gears as in the image A, we imagine two helical gears with opposite teeth as in the image B. If both have their own drives, they complement each other, i.e. these two forces add up no matter whether they are of equal or of different intensity.

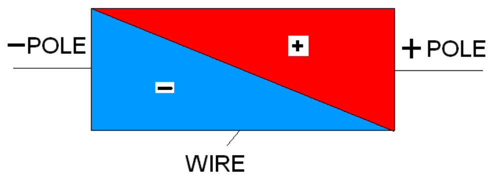
The connection of the electrical segments with the magnetic segment can be thought of in a similar way as the connection of three helical gears at angles of 90°. The two parallel gears have opposing teeth. One of these two attacks in the transverse gear overshot, the other on the other end undershot. This principle of acting of the forces can be encountered in many places, even when we turn a bottle screw closure: the thumb presses into one, the forefinger into the opposite direction of the closure.

When the electric current in the wire is evoked by the movement of the (+)electrified object, this excitation causes only the (+)E-segments to start running, which in turn sets the magnetic segments in motion and through them also the (–)E-segments. But a (+)E-segment also participates in the movement of the adjacent parallel element through its connection to its (–)E-segment (Figure below). Therefore, we can talk about series and parallel connections of the force elements. When we evoke the current through movement of the magnet, this sets in motion only the magnetic segments, which in turn move the plus and minus E-segments. In the part of the wire where the magnet has no direct effect, the action propagates mainly through the E-segments.

Although the electromagnetic element is represented by straight lines, it is only a symbolic representation. Each line represents a flux, and the many elementary fluxes unify themselves in a single electromagnetic flux (principle of self-similarity).

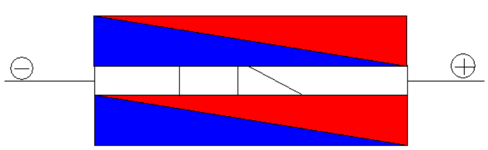
Probably it seems inconsistent that we draw the EM-force element so that the arrows of both E-segments point from their sources outwards on the one hand, while on the other hand we say that the one force has a suction effect. Hence, its arrow should have been drawn in the opposite direction. However, the direction of the arrows does not refer to whether the force acts from the source outwards or inwards, but rather to the effect of the action of both E-segments on the M-segment, that is, on its righting with respect to the wire line.

When the battery poles are connected with a wire, then current of equal magnitude flows through every cross-section of it. But not everywhere is the intensity of the plus- and minus-electricity equal. The plus is the strongest near the positive pole and, as we move away from it through the wire, its strength continuously decreases. The same applies to the minus, but starting from the other pole. Figuratively, we can represent it this way:




The quadrangle has the same width everywhere. This means that the current strength is the same throughout the length of the wire. The red field indicates the strength of the plus, the blue field the strength of the minus. Since the (+)E-forces have the contrary spin to the (–)E-forces, they complement each other in a similar sense as the helical gears mentioned above; therefore, the flux is the same through the entire length of the wire.

Two identical wires are connected in parallel to a battery. A current of equal strength flows through both of them. If we now connect them with a third wire at a right angle (figure below), no matter in which section of the wires, the instrument won't detect any current in the cross wire. However, if we fix this wire not at right angle, but slightly askew, we can measure a small current through it. The greater the inclination, the stronger the current. The current flows through the cross wire in our figure from bottom to top, because the plus/minus ratio down is greater than up. Let's assume that both rectangles are one centimeter wide. The lower end of the cross wire is connected at a position where the plus/minus ratio is 0.7 / 0.3 = 2.3, while the upper end of it is connected at a point where the ratio is 0, 5 / 0.5 = 1. Since 2.3>1, the current flows through the cross wire from bottom to top. The above applies in any case, no matter what kind the wires are. This arrangement in the electrical engineering is known as “Wheatstone bridge”.



Therewith it should be born in mind that the indicated distribution of the intensities of the plus and the minus in the parallel wires will no longer persist after connecting the slanted wire.

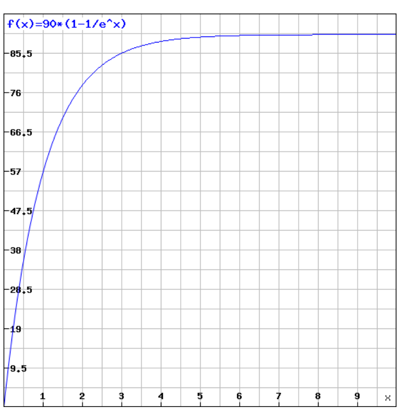
Now we take a compass and put it on a table. We ourselves are turned north, the compass is in front of us and it will be so in all that follows. On its housing we attach a copper wire parallel to the compass needle, i.e., in north-south direction. If we connect the ends of the wire to the poles of a standard carbon-zinc battery (3-6V) and the positive pole is nearer to us, we will see that the compass needle turns to the left (to the west) and stabilizes at an angle of 40-45° in respect to the original north-south direction. (It is desirable to use a compass whose needle is immersed in oil because it stabilizes very quickly in this way. This circuit should not be kept closed long because the battery drains rapidly). Whether we shift the wire to the left, to the right, or up – but still preserving the wire's parallelism to the needle – then nothing changes except the magnitude of the needle’s deflection. If we place the wire under the compass, again parallel to the needle, we get the same deflection; but, now it is to the right (to the east). Exchanging the poles of the battery causes the same to happen, only the other way round. This shows that there is a whirling magnetic field around the wire. The established theory claims that the movement of electrons through the wire forms a ring-shaped magnetic field (like many rings strung on the wire) with a direction of exactly 90° to the wire line.

If we consider the previous experiments without carrying out more, we could think of four possibilities. First, the magnetic field is exactly in the direction the compass needle points (in our case at about 42°). Second, the magnetic field is between 42 and 90°. Third, the magnetic field is exactly at 90° (today's established postulate). Fourth, the magnetic field is oriented over 90° (this possibility comes down to the second). The whole problem of where the magnetic field is directed is due to the influence of the Earth's magnetic field. If we could "switch" it off for a moment, we would immediately see where the magnetic field around the wire is directed and there would be no problem. The first variant could be considered in case the magnetic field in the immediate vicinity of the wire is much stronger than the Earth's magnetic field, so that the force of the latter has only a negligible effect on the needle deflection. The other three variants come into consideration if the Earth's magnetic field is strong enough to influence the needle. In this case, the angle at which the needle deflects is a result of two magnetic fields: the magnetic field of the wire pulls to one direction, while the Earth's magnetic field pulls to the opposite direction; and the result, i.e. the angle at which the needle stabilizes, is somewhere between the directions of the both fields.

All of the variants mentioned, except for the variant asserted nowadays, lead back to a single conclusion: the magnetic wind through the wire is spiral-shaped. We affirm here the second variant: namely, that the twist of the magnetic spiral is not as large as the deflection of the needle shows, but larger; however, the Earth's magnetic field causes this twist to appear smaller in the deflection of the needle. To get a clearer idea of the shape of the magnetic wind in the wire, it is helpful to find a lace with colored parallel threads along it. If we twist this lace, we see that the parallel lines become spirals. The more we twist the lace, the greater the angle between the lines of the spirals and the line of the lace as a whole. There is something similar in the current-carrying wire. The stronger the current, the more twisted are the chains of the magnetic segments; on the other hand, the more aligned are the electrical segments in the direction of the wire line. At a stronger current, the magnetic spiral chains practically reach an angle of 90° relative to the wire, but never ideally. Likewise, the chains of the electrical segments practically reach the angle of 0°, but also never ideally.

The twisting of the magnetic forces in the wire occurs, like many other phenomena in inanimate nature, according to mathematical rules. The dependency that applies in this case can be expressed by the following formula:

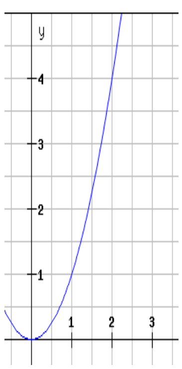
$y = 90° \, (1 - e^{-x})$ or $y = \pi/2 \, (1 - e^{-x})$



Before we explain what this formula means, let's make a comparison. Suppose we have an elastic rubber rod that a strong person can twist to the maximum it can withstand. At the beginning, he achieves a considerable effect with little effort. As he approaches the point of maximum twist, the effort required will increase steeply, and the visible effect will drop just as steeply. So now we have the opposite situation than at the beginning: great force, but little twisting. When it comes to the limit point, the two values tend to the extreme: extreme force, minimal twist. Something similar also happens in the wire. In the beginning, when the current starts to increase, a small increase causes a large twist of the magnetic forces: that is, a large increase in the angle of the spiral field with respect to the wire line. As the twist approaches its maximum (i.e. 90°), an extreme current increase causes only a minimal increase in the angle. We can imagine the curve in our graph as a hill being climbed. In the beginning it is very steep; as we move forward, it becomes flatter and flatter, but never ideally flat. At the beginning we cover a small distance in the horizontal, but manage a large distance in height. When we are almost at the top, we cover an enormous horizontal distance, but manage only a negligible height difference. The enormous distance that we cover in the upper "flat" part is actually the enormous increase of the electric current; in contrast to that, the extremely minimal gain in height is actually the approach of the magnetic spiral to a 90° angle. If in the above formula instead of x we put the current sign I and, instead of y, the angle α, it becomes:

$$\alpha = 90 * (1 - 1/e^I)$$

Let's briefly explain where this formula comes from; at the same time we will recall the math a little bit. As mentioned before, the physical quantities in nature depend on each other and the dependencies can be expressed through mathematical formulas. We have already mentioned one. Let's take a simpler and seemingly purely geometric formula: the area of the square as a function of the side length, $y = x^2$. (Figure below)




If we look at the graphical representation of this formula, we see that the curve at the beginning is little steep and later becomes steeper. The steepness of the curve at a given point is actually the tangent at that point. Since we are talking about mathematical functions of real physical quantities, we must also express the steepness in real numbers from –∞ to +∞ and not in degrees (0-90° or 0-360°), so the tangent in the total horizontal has a steepness of 0, while the tangent line which will be fully upright will have a steepness of +∞; if the tangent is at an angle of 45° with the X-axis, then the steepness is 1. In mathematics this is called tangens, which is another word for tangent. If the steepness is 1 (=45°), we have covered the same distances in the horizontal and in the vertical, i.e. their ratio is 1. We see that the steepness is the mathematical relationship between the vertical and horizontal line segments if the curve at a given point continues to run as a straight line (tangent), i.e. the inner physical dependence that this curve represents suddenly ceases to apply. We get an idea of this when we turn a keychain on a string: the string suddenly breaks, and the hitherto effective physical laws cease to apply; thus, the keys fly in a straight line pursuing the tangent of the point when the forces stopped acting.

If we look at a tangent of a given point on the curve, we will see that the farther we move on the tangent from the point of contact, the farther we move away from the curve itself, and vice versa - the closer we approach the point of contact, the smaller is the difference between us and the curve. When we are very close to the point of contact, we can say that the difference is negligible, or that the tangent and the curve overlap on this very small line segment. Therefore, we can calculate the steepness at a given point if the values of the function at two near points - and that is the height difference on the vertical axis - are divided by the distance difference on the horizontal axis. If we denote the latter as $\Delta x$, then the height difference becomes $f(x + \Delta x) - f(x)$, and so the steepness (S) = $[f(x + \Delta x) - f(x)] / \Delta x$. Applying this to the function $x^2$, we obtain:

$$S=\frac{f(x+\Delta x)-f(x)}{\Delta x}$$

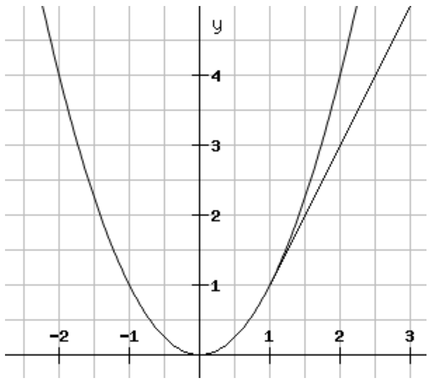
$$S=\frac{(x+\Delta x)^2-x^2}{\Delta x}$$

$$S=\frac{\cancel{x^2}+2x\Delta x+\Delta x^2-\cancel{x^2}}{\Delta x}$$

$$S=\frac{2x\Delta x+\Delta x^2}{\Delta x}$$

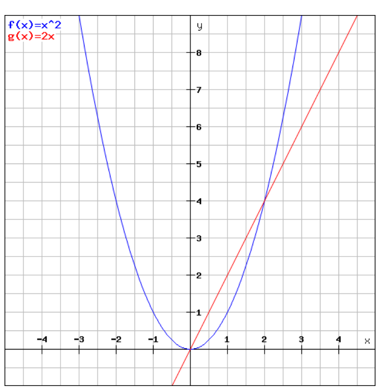
$$S=\frac{\cancel{\Delta x}(2x+\Delta x)}{\cancel{\Delta x}}$$

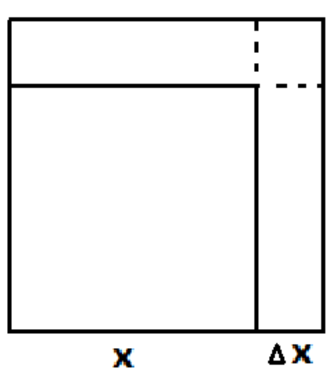
$$S=2x+\Delta x$$




As we have said, we assume $\Delta x$ to be very small, practically zero, so only 2x remains for the steepness. We see that the steepness is a continuous function as well as the basic function, which one could have expected. This means that for any given point x we can now not only specify the value of the function, but also of the steepness at that point.

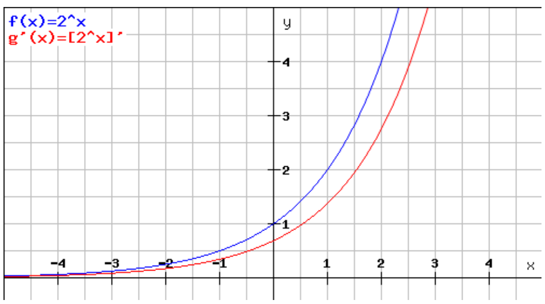
If we draw both functions together into a coordinate system, we see that the steepness is greater than the basic function from the beginning to the point x=2; they intersect in the point x=2, y=4, that is, they are equal, then the steepness is less than the basic function. What does this mean, and what does “2x” mean actually? Let's look at the figure below (right). There we see a smaller square, which has grown up a bit in the way that it is extended to the right and up. The increase can be divided into three sections, two rectangles and one smaller square. The rectangles have equal areas, x times $\Delta x$, and the small square is $\Delta x^2$. If we extend the initial square only slightly, then $\Delta x$ is very small, so we can neglect $\Delta x^2$ in comparison to the areas of the two rectangles. Their total area is $2x\Delta x$. We see that this 2x means the expansion of the square in the direction of its two sides where the rectangles are attached. Even if we say that the square "pumps" itself on all four sides equally, there is absolutely no difference compared to that if we say the square expands on only two adjacent sides. If we look for the steepness of the function $x^3$ in the above-mentioned way, we get $3x^2$. The function $x^3$ is the cube content. The increase in cube content is due to the expansion on three (3) of its sides, which are squares ($x^2$).

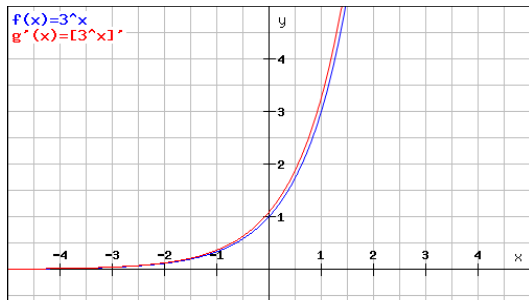


The fact that the steepness of the function $x^2$ is greater at the beginning and later smaller than the value of the function itself comes from the fact that for a very small square, even the small growth is larger than its initial area. For a large square, however, a small growth is much smaller than the initial area. In this context we can also make a comparison with life. The physical and mental changes of a child between the ages of one and two will be incomparably greater than those of an adult during the same period of one year. It's similar to spending money on different goods. An increase in price of one thousand euros when buying an apartment is easier to agree to than to the same increase when buying a computer.

Let's look at the two exponential functions $2^x$ and $3^x$. If we draw their graphs along with their steepnesses, it will look like the figures below. The blue curve is the function, the red is its steepness. In the first function $2^x$, we see that the steepness is always smaller than the function; but, in the case of the $3^x$ function, the steepness is always greater than the function. Somewhere between the numbers 2 and 3 there will be a number 2,…., which will form a function whose two curves, function and steepness, are congruent. This function can be found in the number 2.7182818 ... or $2.7182818^x$ . This is the so-called Euler number, denoted by the letter e.

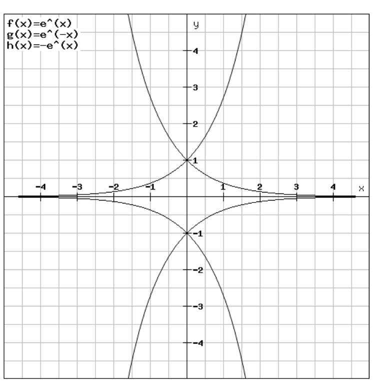



The function $e^x$ is the only mathematical function that has a steepness identical to itself. Is that supposed to mean something? It means that the physical processes that unfold under this function have such inner constitution and dependence that the general increase is a true reflection of the increase in each elementary part of the physical process. As we have previously said about the square and the function $x^2$, we have seen that the steepness at the beginning is greater, but later smaller than the function, and that the overall increase can be reduced to the increase at two adjacent sides of the square. However, "$e^x$" is a different story: the wholeness is a true copy of each of its elements. In nature and in mathematics there is something called self-similarity. A beautiful example of this term in nature is Roman broccoli. Considering it, we see that the whole plant is a true reproduction of each of its parts. We observe the same in magnetism. However much we divide a magnet, its parts will again behave like the wholeness.

If we change the signs before “e” and its exponent “x”, i.e. if we use the four possible combinations (+ +), (+ −), (− +), (− −) we get four variants of the function $e^x$, namely $e^x$, $e^{-x}$, $-e^x$, $-e^{-x}$.

If we plot them in a single coordinate system, we get the following symmetric image:



Except for the $-e^x$ variant, we will see that all other variants can serve in the representation of the physical correlations of the electric current. We have used the variant (− −) or $-e^{-x}$ for the formula developed above. Since this function asymptotically approaches zero and we need approaching to 1, we will add 1 to this function and raise it by 1, giving "$-e^{-x}+1$" (or $1-e^{-x}$). The maximum value 1 of this function in our case is 90°, thus we multiply the entire expression by 90 and get $90 \cdot (1-e^{-x})$.

In the function $e^x$, the increase in growth is equal to the increase in increment; while in this function, $-e^{-x}$, the increase in growth equals the negative increment, or the decrease. The same speed with which the function grows, its increment decreases. In other words, the steepness of the function ($-e^{-x}$) is the function ($e^{-x}$).

For these reasons in the formula for the angle of the magnetic field with respect to the wire line we have used the exponential function with the Euler's number. If we put in it the values 1,2,3,4,5,10 and 30 for the current strength, we get the following results:

I = 1, then α = 56°

I = 2 α = 78°

I = 3 α = 85,5°

I = 4 α = 88,4°

I = 5 α = 89,4°

I = 10 α = 89,9959°

I = 30, then α = 89,99999999991577°

We see that the angle very soon (0 to 5) reaches almost 90°. What are these values 1,2,3,4,5,10 and 30 for the current? They are not amperes, the unit of measurement for the current strength, as we will see soon.

Therefore let us say something about the measurement units. With the emergence of the modern empirical science, it has become necessary to abandon the old measures such as inch, foot, etc. and replace them with precise units. Considering the fact that everything that is measured in the last instance comes down to measuring space and time[6], there was a need first and foremost to have a precise measure of space, because the measure of time the humans possessed for a long time.

But nature is in perpetual motion and everlasting change and there is nothing permanent and unchanging on which man can rely in establishing the units of measure. Therefore, he must conceive them arbitrarily. In this way he has set the meter, namely by means of a metal rod which is kept in Paris. The length of the rod he has divided into 10, 100 and 1000 equal parts, which he calls decimeters, centimeters and millimeters. When the meter was set, mass came next. What helped here was water, easily available and easy to produce in pure form, since in the case of measures an important moment is that they should be reproducible everywhere and as easily as possible. A container in the form of a cube with the inner length of one decimeter is filled to the brim with pure water and placed on one side of a balance scale. On the other pan, pieces of pure metal were placed until the scale had ideally balanced. The container was afterwards completely emptied and put back on the scale. Then some of the metal pieces were removed until the scale had balanced again. People then said that the taken pieces of metal weigh as much as one $dm^3$ of water, a liter. They fused the pieces of metal in a single piece and called it kilogram.

[6] Measurements with all analog instruments are based on measuring space, whereas measurements with all digital instruments are based on measuring time. For example, at measuring temperature with a mercury thermometer we measure the space for which the mercury has expanded under the influence of heat. That we measure time with a digital thermometer (but also with a digital instrument for whatever physical quantity), we will see later.

We see that man is forced to set the measurements arbitrarily. When it was discovered at the end of the 18th century that two plates of different metals partly immersed in a container filled with diluted acid produce a force then called electromotive force (EMF) (now called voltage), and that different metals in different agents produce different intensities of this force, one had to find a unit of measure for that force. As a physical standard of measurement (etalon) the so-called Daniel cell was selected. The electromotive force this cell gives off was called a volt (1V). Due to its stability, the Weston cell was later chosen as a volt standard. Since these two cells differ by about 0.1V in voltage, the agreement of what should be considered as one volt was also changed.

But this is only the potential force. The current (i.e. the kinetic force) that this cell will give off depends on the material and on the dimensions of the wire by which the plates are connected. The reason for this dependence was called resistance. Thereby one had to set a unit of measurement for this quantity. The unit was established with the help of mercury because this metal was easy to produce in its purest form. In addition, it has a large specific resistance, thus with smaller amounts considerable resistance can be produced. A mercury-filled, circular glass tube with wires protruding from the ends was chosen as a standard for resistance (one ohm/1Ω). The tube was one meter long (later modified to a length of 1m and 6 cm after a settlement between the USA and Europe), and its area in cross-section is one millimeter squared. These two units of measurement, volt and ohm, served to define the strength of the current. When resistance of one ohm is connected to a source of one volt, then the current flowing in this circuit is one ampere (the voltage of the source must not fall in the course of this). We see that the unit of the current strength could have been a different one if a different kind of cell was chosen instead of the Weston cell; or if, instead of mercury, one had taken another metal, or the same but with other dimensions of the wire.

In order to match the above formula with the unit ampere, it is necessary to insert a constant before the "I". Its value must be significantly greater than one, because even at considerably lower currents than 1A, the angle is almost 90°.

> Lower currents than 1A should not be considered as small currents, because 1A is a quite large unit. For example, when 30mA flow through the human body, it causes a severe electrical shock, which can be fatal to some individuals. This does not mean that if we interrupt a circuit in which 30mA flow and then touch each of the two ends with one hand, we would be killed. In this case, a significantly lower current than the 30mA would flow through our body because it is an additional, fairly great resistance in the circuit. As small currents one can consider those in the order of micro- and nanoamperes.

Let's clarify one more thing about magnetism. As we can easily notice, the poles of the same name repel and the different ones attract each other. If we bring two identical bar magnets together like the Roman numeral II with the plus poles up and the minus poles down, they will repel one another and we cannot bring them together. In order to bring them together in this arrangement, the poles must be reversed against each other. So we get "one" magnet with bipolar ends. The two magnets would never come together in this way if they could move freely, i.e. if they were not forced to come together like that. If allowed to move freely, they join together in a row so that the magnet becomes stronger. If we now take a bar magnet and slowly lower it towards the compass, so that the magnet and the needle are always parallel, then the needle will either not deflect or suddenly will turn by 180°. It makes another movement to connect in series, but it is imperceptible because the needle is fixed in the compass housing. So it is clear that the compass needle aligns itself reversed to the bar magnet. Based on this, we might think that the needle under the wire would settle reversed to the magnetic field of the wire. This is however not the case. The needle places itself in accordance with the magnetic field of the wire and thus strengthens the field. The following experiment shows this. If the minus of the battery is "up" and its plus is "down", the needle makes a deflection to the left, i.e. to the west. Now we break the circuit and coil the wire in few circles. When current flows through this coil, it behaves inside like a permanent magnet.[7]

The coil with its center now we bring near the lower end of the compass needle and then connect the coil to a battery so that the plus pole is on the right and the minus pole on the left. Let us recall how the first configuration was: the wire over the compass, plus "down", minus "up" - deflection to the left; now, in the second configuration, as if we turned the wire counter-clockwise by 90°, we had a part of it transformed into a coil and placed this coil "below" the compass needle. The upper segments of the turns of the coil have the same magnetic field under them as the straight wire in the first configuration, except that this time the magnetic field is rotated 90° counter-clockwise. If we now connect the ends of the coil to a battery, we will see that the needle turns 180°.

It follows that the upper segments of the turns have under themselves a magnetic field whose positive pole points in our direction (that is, to the south). It means that when the wire was straight and positioned in north-south direction, then the positive pole of its magnetic field under it was oriented to the left (that is, to the west).

In order to better understand the proof that the magnetic field in and around the wire is spiral-shaped, we will first mention something that is well known from everyday life. If two children sit on a roundabout seesaw with two seats, it will be much easier for us to turn them from outside than to do it from the very rotation axis. In the latter case, we may not be able to move them at all. We mention this because the experiment to be described now is to set the magnetic needle in motion by acting on its axis.

In order to show that the direction of the magnetic field of the current carrying wire differs from 90°, we will position the wire exactly 90° over the compass needle, i.e. in east-west direction. The needle and the wire must form an exact cross. But to demonstrate this, we need a new strong battery (let's say 9V), because we need – recalling the example with the roundabout seesaw – a great force to cause a movement of the needle from its very axis. There is something similar also here: the magnetic field will attack the needle at its axis point. The strong battery, in turn, short-circuited only with copper wire, will give off a strong current and the magnetic field of this current is practically at 90° with respect to the wire. The circumstances are very tricky, which is why we have to be very precise. The procedure consists of two important points. First, the wire must be precisely at right angle to the needle. Second, the wire should begin to bend on both sides some distance from the needle for its ends to meet in the battery. These curves must be far enough from the needle. If this is not the case, the magnetic field of the curves will affect the needle, which will make the experiment inaccurate. When this experimental setup is ready, we close the circuit. If the positive pole of the battery is left, then the needle twitches very weakly but still noticeably to the right (to the east); and, if the positive pole is right, then the needle moves to the left - at the beginning very slowly and with great difficulty, and later accelerating to settle at an angle greater than 90°. The Earth's magnetic field prevents it from turning further. What is indicative in this experiment is that the tiny twitch when the plus is left is always to the east; while, with plus right, the big deflection is always to the west. We consider this to be a sufficient proof that the magnetic field around the wire is not at right angle to the wire line. If it were at right angle, then the compass needle should not move in either case.

The simple experiment we are about to describe now is of essential importance to understanding of electric current, but is not mentioned in the science of electromagnetism anywhere. Only in the text of

[7] When we make a coil from a straight wire, we actually cause an inversion. In the first case, we have a straight wire and a spiral magnetic field and, in the second, a spiral wire and a straight (*but twisted*) magnetic field.

Hans Christian Oersted after the discovery of the magnetic effect of the current carrying wire, a brief remark is made, which can be understood in this direction (we will quote it further down).

Let us take two pieces of wire of equal thickness, but of different metals, which have an enormous difference in their specific resistances – say, one of copper, the other of kanthal[8]. If we connect the two wires in a series and position this “one” wire in north-south direction, place a compass under each piece, then connect the ends to a battery, we will see that the deflections of the two needles are different. The needle under the copper wire deflects more than that under the kanthal wire.

On the other hand, when we connect two pieces of kanthal wire of different cross sectional areas and then place a compass under each one, we notice again that each of the two needles makes a different deflection. Under the thinner wire piece we see a bigger deflection than under the thicker one. Moreover, one also feels a greater warming of the thinner piece.

The explanation of these experiments is as follows. If we have several wire pieces of different metals and of same thickness connected in series, then the deflection of the magnetic needle is larger next to the wires of electrically more elastic metals[9] (silver, copper, aluminum), because the more elastic material has a smaller resistance. In such material the electric segments tend more easily to the wire line, which on the other hand means that the magnetic spiral is pushed closer. As the elasticity of the metal becomes lower, so the electric segments exert a greater resistance to being inclined to the wire line, which in turn means that the magnetic spiral is further pulled apart and therefore the deflection of the magnetic needle is smaller. Now that the electric spiral is more compacted, it means that the electric flux has a longer path to go through this than through a wire segment of a more elastic metal connected in series. Given that the electric flux is the same throughout the circuit, it follows that in the less elastic metal the trembling of the E-forces must be faster in order to keep pace in the transfer of the flux with the more elastic metal. The faster vibration of E-forces leads to more frequent friction between the plus and minus E-segments, resulting in a greater release of heat.

When several wire pieces of a same metal of varying thicknesses are connected in series, then in the thinnest piece of wire the electric wind will flow fastest (similar to how the air flows fastest in the narrowest pipe section in a series of differently wide pipes); therefore the greatest leaning of the electric segments to the wire line takes place here, which at the same time means the greatest righting of the magnetic segments in respect to the wire line (that is, the most compacted magnetic spiral), manifesting itself in the largest deflection of the magnetic needle. Since the vibration of the EM-forces is the fastest in the thinnest wire in order to keep up with the flux transfer in the thicker wires, the greatest heat is also generated here and, in extreme case, light too.

Considering that the electric flux through all the wires of a closed series circuit is the same, it follows that the magnetic flux through them, or the strength of the magnetic field around them, must be the same everywhere. As we know, physical forces can be represented by vectors. The direction of the vector represents the direction of the force; its length represents the strength of the force. In our case, if we should represent the magnetic field around the various wires of a circuit by vectors, they will be everywhere with equal length, but not everywhere with the same direction.

Since the cross sectional area of the wire and the specific resistance of the material act inversely proportional to the angle of the magnetic spiral, we will write these two under the fraction bar of the exponent, in which previously we had only the current; thus, we obtain the following formula for the angle α:

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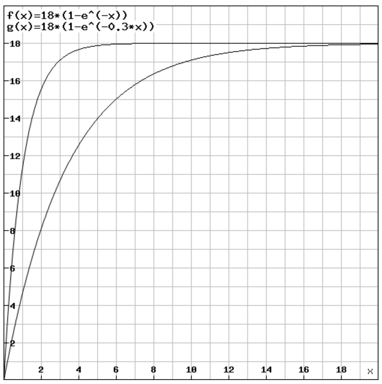
[8] Kanthal is a metal alloy which is electrically high resistive.

[9] As it is so natural to speak about elasticity of materials in a mechanical sense, so it is to speak about their elasticity in an electrical sense.

α = 90° (1-e^(-k*I/ρ*S))

The letter k stands for a constant that adjusts the formula with the currently accepted units of measurement, and which in our estimation should be significantly greater than 1. This formula calculates the angle of the magnetic spiral in each part of a series circuit.

If we plot the two following exponential functions α = 1- e^(- a·I) and α = 1- e^(-b·I), substituting for a = 1 and for b = 0.3, we get the following figure:




The number a=1 is an arbitrary chosen value of "k/ρ·S" for one of two wires connected in series, b =0.3 is such a value for the other wire. From the graph we see that with increasing current the angles of the magnetic spiral in both wires become practically equal. If the resistivity ρ and the cross sectional area S of the second wire increase, the lower curve will become even lower and even farther along the X-axis it will approach the maximum value, that is, at greater current it will approach the first curve. Accordingly, there will be practically (but not factually) no difference between the angles of the magnetic fields around the two wires at stronger currents. Such differences should be noticeable at lower currents. But at lower currents, however, not only the angle but also the strength of the magnetic field decreases, so that then it has no strength to overcome the inertia of the compass needle and its tie to the Earth's magnetic field to cause its deflection. However, when the strength of the magnetic field is great enough to cause a deflection of the needle, then the angle is already very close to 90°. Therefore, with two wires connected in series, which don't have a big difference in their resistivities, the difference in the angles of the magnetic needles cannot be noticed with the naked eye, but only with precise instruments. For those that have an immense difference in their resistivities, the difference in the angles is perceptible to the naked eye.

The different deflections of the magnetic needles over different pieces of wire of a closed electric circuit could be regarded as a manifestation of Bernoulli's principle in the case of electric flux.

As we have already mentioned, there are indications in Oersted's work that point in this direction, namely, in his writing of 21 July 1820 with the discovery of the phenomenon that a magnetic field builds up around a current-carrying wire. Oersted, however, mentions this only very fleetingly and since that time it appears nowhere else. He writes: "The uniting conductor may consist of several wires, or metallic ribbons, connected together. <u>The nature of the metal does not alter the effect, but merely the quantity.</u> Wires of platinum, gold, silver, brass, iron, ribbons of lead and tin, mass of mercury, were employed with equal success."

The underlining is from the author of this work. The effect of which Oersted speaks, evident from the exposition before, is the deflection of the compass needle. This means that for different wires connected in series everything is the same ("equal success"); only the quantity, that is, the angle of deflection changes.

The external manifestation of the magnetic wind in the wire is the magnetic field around the wire, the external manifestation of the electric wind in the wire is the heat and possibly the light around the wire. Through the external manifestation we can measure the intensity of what happens inside, that is, the current strength. Light does not develop in every electrical circuit and measurements through heat generation are difficult to carry out. What remains is magnetism. In practice, with analog instruments, the current is measured almost exclusively through the strength of the magnetic field.

Although we sometimes use the phrase “current flows”, there is nevertheless nothing material flowing through the wire; rather, it blows through it an immaterial electric and magnetic swirling wind, **both from the positive to the negative pole of the battery; namely, the magnetic wind in clockwise- and electric wind in counter-clockwise direction.** Motion of matter on the electric waves exists only inside the battery. We speak of waves because every single vibration of the forces is a wave. The vibrations come therefrom, that the electrical resistance of the material relentlessly opposes the ordering of the EM-forces, but the power of the electric source restores the order anew. We can think of the electromagnetic wind as of something that comes in rushes, similar to the flux caused by a fan comes in rushes. Every single blade of the fan grasps and moves onwards a certain portion of air. Because of the high frequency of these rushes, it appears to us as a continuous flux.

For current to flow through a wire, no closed circuit is needed. We have seen this at the beginning of this work with the free end wires of the so-called plus and minus electric circuits. We can see the same when we use the phase tester (one-contact neon test light) to determine which wire is the phase. The phase tester is a series connection of a high value resistor (hundreds of kilo-ohms) and a small neon lamp. It is sufficient to touch the end of the phase tester with a finger when its other end is touched to the phase to make the lamp light up. Why is this necessary? We will use a comparison to explain it. If a turned on hair dryer or vacuum cleaner is brought close to a fan that does not have its own drive, then the fan is turning. But if we attach the fan to a wall, and if we bring the hair dryer or the vacuum cleaner close to it, it will not turn. The reason is that behind the fan there is no free space *filled with air* in which the flux can spread or from where it can suction. The same happens with the electric flux. Touching the end of the phase tester, we are becoming the "air space", actually the body with sufficient electrical conductivity whereto the flux can spread or wherefrom it can suction, and consequently the lamp lights up. In German it is called Masse - material conductive mass (English: ground).

Interesting is another experiment with the described plus and minus transistor circuits, which, because of its importance, will be analyzed also later when we will talk about the semiconductors. Instead of a long wire from the heart of the plus circuit, this time with a long wire we extend either of the two other leads of the plus transistor. From the heart of the transistor there is no wire at all. Apart from that, the experimental setup remains as in the basic experiment from the beginning of this paper. If we move an electrified glass toward or move it away from the wire’s free end, which is far from the circuit itself, then nothing happens. But if we now connect to the lead of the heart a wire piece of 10-15cm or more (the other end of the piece is free) and again act with the electrified glass on the end of the first wire, then the lamp lights up. Now the situation is opposite to the one in the basic experiment. In that experiment the lamp lit up when we moved the glass toward the heart wire; here it lights up when we move it away from the non-heart wire. But this could not happen without the small piece of wire from the heart of the transistor. This short wire is actually mass (ground), material conductive “space" in which the flux - evoked in the long wire by the movement of the glass – can spread and thus more powerfully excite the heart from the other side, passing first through the N-part of the transistor.

The largest conductive body, i.e. mass, is the Earth. This mass is most commonly used for grounding electrical equipment, lightning rods, antennas, long-distance power lines, etc. But it is a good mass only if it is sufficiently moist. In long dry summer months it is not a very good mass. The Gobi Desert, the driest place on Earth, would be a bad mass too.

Although the electric flux does not need a closed circuit, still the flux in a closed circuit is much stronger because the blowing of the positive from one side meets the suction of the negative from the other, thus multiplying the effect many times. The order of the aforesaid can also be reversed.

If we connect two light bulbs, one 100W and the other 60W, parallel to 220V-240V, the first shines more brightly than the second. If we connect them in series, then the 60W bulb shines more brightly than the 100W bulb. In the second case both shine much weaker than in the first. Ordinary light bulbs consist of very thin tungsten wire; that is, they are resistors with certain resistance. In principle, any wire of such dimensions would shine, but would immediately melt and thus break the circuit. Tungsten has the highest melting point among metals (3400°C) and will not melt even at temperatures as high as those in the wire (over 2000°C).

We see opposite situations here. In the first case, there is equal voltage applied to both bulbs but different currents through them. In the second case, the same current flows through both bulbs, but the voltages at their ends are different.

The energy consumed in the first case is obviously greater with the 100W bulb and smaller with the 60W; in the second case, it is reversed. The total energy consumed in the first case is significantly greater than that in the second.

The 100W light bulb can be thought of as a shorter wire and the 60W as a longer wire, both of same thickness (we can think of the 100W bulb as a thicker and the 60W as a thinner wire, both of the same length; but, here we stick to the first conception).

From everyday life we know that, when transporting a weight from A to B, physical work is done. The further apart places A and B are, the greater the work done. But the work done also increases the heavier the weight is. Work is therefore a product of the weight of the object (the force) and the distance over which it has been transported. If we denote the work with the letter A, the weight with F and the distance with s, then A = F * s, or A = m * g * s.

Just as by the air flow through a pipe we can speak of an amount of air passed through it (expressed in $m^3$) due to the action of a propeller, so can we speak of a quantity of electricity passed through a wire thanks to the action of a battery. If we denote this quantity by the letter Q, then this Q when divided by the time (Q/t) will result in the magnitude of the electric current, just as $m^3/s$ would give us the magnitude of the air flow through the pipe. When the electricity has flowed through the wire a certain length, then the work done, i.e. the energy consumed, is proportionally dependent on the length. However, since the electric flux usually encounters different resistances in the various wires that make up the circuit (as opposed to the transport of weight where the resistance, i.e. the gravity, is the same everywhere), the length of the path is of no significance, whereas the voltage difference between two given points of the circuit is crucial.

Therefore, the term for the consumed energy will be Q*U. Above we used the formula F*s for the energy consumed, where F is the product of the quantity (mass m) and the resistance (gravitation g) against which the quantity moves; the distance (s) was expressed separately. In the case of the current, the quantity Q is noted separately, whereas the resistance against which the flux moves and the path it travels are summarized in U, because the greater the voltage difference between two points in the circuit, the greater the resistance. On the other hand, since we cannot measure the quantity Q, but the current I, which is Q/t (hence Q=I*t), we write I*U*t instead of Q*U, and can thus determine the energy consumed in a certain resistor (or the work done for the transfer of the flux through it).

If two workers carry equal parcels over a certain distance AB, but the first moves faster than the other, then the former will carry more parcels in a certain time. He does more work in a unit of time. We say that his effect (power) is greater. We can also put it another way: they carry the parcels at the same speed, but the first carries heavier parcels: again, the former achieves a greater effect. This physical quantity, i.e. the effect is F * s / t.

As we said above, we can think of the light bulb of 100W as a shorter wire, that of 60W as a longer wire, both of equal thickness. If both are connected in parallel to 220-240V, then stronger current flows through the shorter wire, so that the power I * U is greater here (although the path is shorter, however, a significantly bigger "load" is transferred here). When both wires are connected in series, then the same current flows through both bulbs, so that the power U * I is of course greater in the longer wire (the "load" travels a longer path).

In the case of the parallel connection, the current that the source gives off is significantly greater than in the case of series connection (in the first case both lamps shone much brighter). Therefore, we characterize the parallel as plus connection (expansion, intensification of effect) and the series as minus connection (contraction, attenuation of effect).

These two types of connection we can imagine as a thicker, cylindrical piece of plasticine, which becomes thinner and longer as we roll it between our hands, and then we knead it back into the original shape. During the first process we make a series connection out of a parallel. When we knead it back, we make a parallel connection out of a series. If we imagine the two processes as incessant pulsing, then the first action is minus, the second plus. We equate the thickening with the parallel connection because it makes no difference from the point of view of the current source, whether we connect two identical wires in parallel or melt them together in a wire of the same length and greater thickness.

The resistance of a wire can be determined by the following formula: $R=\rho \cdot l/S$, where $\rho$ is the resistivity of the material, l the length and S the area of its cross section. The lowest specific resistance has silver, the highest mercury. Because mercury was used to determine the measurement unit of resistance, its resistivity is also the reference point 1 with respect to which the resistivities of other materials are determined (it is actually slightly lower than 1 because of those added 6cm). The value $\rho$ for materials which have a higher resistivity than mercury (that is, alloys) is greater than 1, for the materials with lower resistivity the value is less than 1. From the formula we can see that the longer the wire is, the greater the resistance; the thicker the wire, the smaller the resistance. We can also say that in the length l we have the series connection and in the cross section area S the parallel connection.

Instead of speaking about the resistance of the wire, which we have determined as minus quantity, we can also speak of the conductance of the wire, which will be a plus quantity. The conductance is $G=1/R$.

With several wires connected in series (minus connection), their resistances (minus quantities) add up; with several wires connected in parallel (plus connection), their conductances (plus quantities) add up.

$R=R_1+R_2+R_3+\ldots R_n$ series connection (minus)

$G=G_1+G_2+G_3+\ldots G_n$ parallel connection (plus)