Abstract

The article has intention to show that present set of basic equations of electromagnetism is not completely true. The equations do not contain speed of charge carriers and in the text is shown that this parameter cannot be omitted. If we accept that electric field has its own velocity identical to moving charges that produce corresponding magnetic field than appropriate formulas for magnetic field have to contain velocity of the charges. There is clearly shown that M hypothesis of Faraday's wheel is correct and N hypothesis is wrong and thus the electric field has its own velocity.

It is also shown that wrong concept was applied on derivation of formulas for force of attraction between two current elements because they were all derived by observing of electrically neutral conductors. The approach led to completely wrong conclusion that electric field is non-moveable one. Further mistakes had been producing automatically after all these wrong initial presumptions that were all "experimentally proved" too. There is also shown that these experiments had to be wrongly explained otherwise some basic laws of physics are seriously violated.

All most important formulas for interaction between two current elements and the most valuable formulas for interaction between two moving charged particles altogether with brief criticism of each particular ones are listed in this article.

These all are shown in a simple and intuitive way without forcing intensive usage of higher mathematics and some exotic and non-commonly known concepts.

The article should be conceivable to all people attended high school that also use to think occasionally about physics phenomena and laws.

RIGHT WAY OF OBTAINING TRUE ELECTROMAGNETIC EQUATIONS
WHERE IS A MISTAKE DONE?

Today we all commonly accept that Maxwell and Einstein equations are correct ones. But, are they?

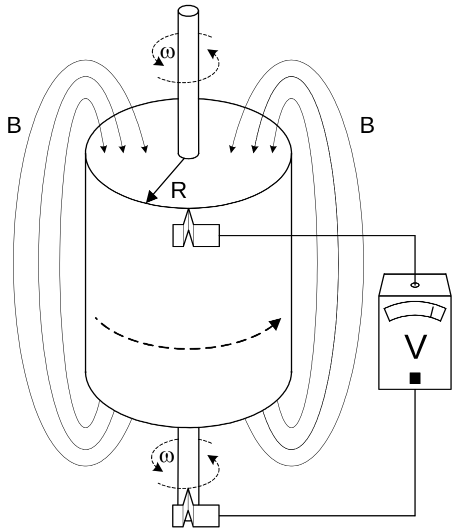
The Twins' paradox clearly shows that Einstein[1] special theory cannot be fully correct and that General theory is valid only until twins do not use boson's particles in their mutual communications. Beside that, the theory of relativity contains some very convenient generalization that facilitates its derivation but further analysis of the theory leads us directly to the some inconsistence: there is a consequent question whether gravitation distorts space or time? If we apply gravitational red shift to the photon we can derive the same equation for frequency distortion as one obtained by applying formula for time axe distortion by the gravitational field. Einstein equation for the influence of gravitational field to the time also contains the radius although it should not exist there because it is not field parameter at all. This clearly shows that gravitational field is not only variable that has influence on speed of time flow in Einstein's theory.

Regarding the fact that Einstein derivation is quite correct there is a question where was done the mistake?

It seems that the mistake is hidden very deeply in the basis of modern physics. Let we consider the hypothesis: main and probably wrong premise was done at the first part of 19th century when was deduced that electric field is not movable, i.e. that it is

[1] Albert Einstein, 1879 – 1955

static one and that only the sources of the field can be moveable. This presumption involves some very serious violations of basic physics axioms like law of momentum conservation and the law of energy conservation.
Anyway, Faraday[2] had proved that E field is not moveable in famous experiment in which device known as Faraday's wheel was used as dynamo machine to produce electricity. The draft of the device is shown on the picture below:



The wheel is consisted of a circular permanent magnet rotating over its axe of symmetry. We believe that during the rotation, magnetic field arising from permanent magnetic disk is not moving on and thus it induces electric field in the rotating disk itself.
I will try to derive here a bit different equation for force between two infinitely long and parallel conductors based on moving charges only. If the approach is correct it should be able to yield similar equation to one of quantum Hall[3] effect.
Approximate value of electric field is given by the following formula:

$$\vec{E} = \vec{B} \times \vec{v} = \vec{B} \times (\vec{\omega} \times \vec{r}) = (\vec{B} \cdot \vec{r}) \cdot \vec{\omega} - (\vec{B} \cdot \vec{\omega}) \cdot \vec{r} \tag{1}$$

Whereas:

$\vec{E}$ = electric field,
$\vec{B}$ = magnetic field,
$\vec{v}$ = velocity,
R = radius of magnetic disk,
$\vec{\omega}$ = angular velocity,
U = electric potential.

Since $\vec{\omega} \perp \vec{r}$ and $\vec{B} \perp (\vec{\omega} \times \vec{r})$, we have finally:

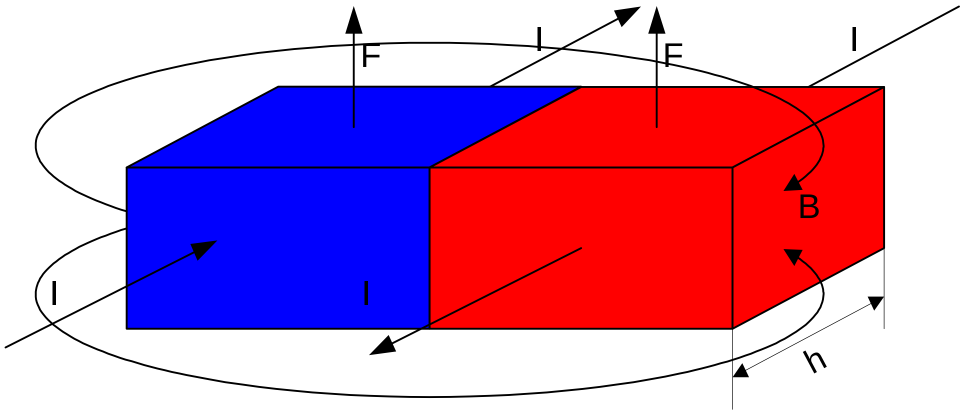
$$E = B \cdot \omega \cdot r \tag{2}$$

[2] Michael Faraday, 1791 – 1867
[3] Edwin Hall discovered it in 1879. Henry Rowland previously theoretically predicted the effect. The quantum Hall effect is Hall effect which formula is extended with parameter holding number of valence electrons in conductor.

All angles are mutually perpendiculars as it is already mentioned, thus the computation of the value for electric potential using the above formula is quite simple:

$$U = \int_0^R \vec{E} \cdot d\vec{r} = \int_0^R \left(\vec{B} \times \left(\vec{\omega} \times \vec{r}\right)\right) \cdot d\vec{r} = \frac{\omega^2 \cdot R \cdot B}{2} \qquad (3)$$

The presented equation is in excellent concordance with Faraday's experiment and it was adopted as proof that magnetic field is static one and thus it induces electricity in rotating conductive magnet.
But, let we rearrange the experiment a bit: regarding the theorem of reversibility of DC machines/generators we can conclude that the mechanism will behave as a DC motor whenever we push the current trough it. Also regarding the basic Newton[4] law of action and reaction we can conclude that the machine must have stator on which it will repeal. I.e. the machine could not act as motor because there is no prop for reactive forces.
In regards with the presented explanation it could be deduced that the device will repeal from the unmovable ether if it could work. Further investigation in the direction would lead us to the serious violation of the law of linear momentum's conservation. But, anyway if it could work it would mean that new kind of star drive is a step away from us, e.g. means that simply flow of electric current trough the permanent magnet would produce the force as it is shown on the picture below:



Without any modification we could use above device as velocity sensor simply by measuring voltage induced by the magnet movement:

$$v = \frac{U}{B \cdot h} \qquad (4)$$

Whereas:

- v = absolute velocity,
- U = electric potential.
- B = absolute magnetic field,
- h = width of magnet.

[4] Isaac Newton, 1643 – 1727

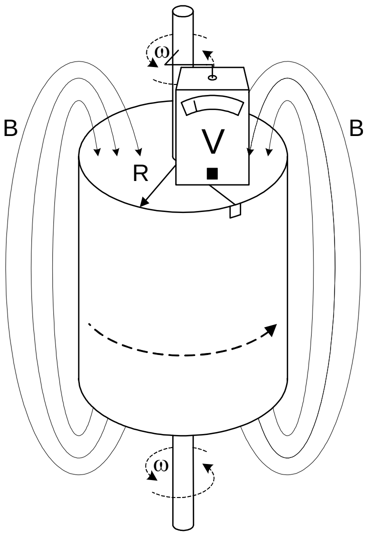
Due to relativity of velocity discovered by Galilei[5] we can conclude only that the result of Faraday's experiment was badly explained because there is no way for absolute velocity to be measured on. This could not be perfectly true because we can determine absolute velocity to the center of Big Bang measuring Doppler shift of homogenous background radiation (see COBE project). If the radiation really has origin in Big Bang happening, than its variation in spectrum can have origin only in velocity of observer that performs measuring. The radiation is everywhere and it should be homogenous for non-movable observer because the center of Big Bang is spread to everywhere creating everything in our universe.
Let we neglect contra arguments for a moment: if all above are true the permanent magnet could work as propulsion motor too, i.e. it could be used as force generator on various flying vehicles instead of the helicopter's propeller. Regarding present theory it should produce the force of the following value:

$$F = B \cdot \int_0^h I \cdot d\ell = B \cdot I \cdot h \qquad (5)$$

Whereas:

B = absolute magnetic field,
I = electric current,
h = width of magnet.

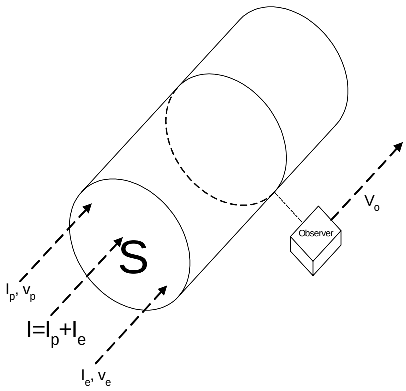
And this is not possible due to law of linear momentum conservation.
Let we rearrange Faraday's experiment a bit by putting the voltmeter device to the spinning permanent magnet directly as it is shown on the following picture:



Voltmeter is measuring difference of potential between shaft and border of the spinning disk now. The conductors that lead to voltmeter should be protected from the influence of magnetic field by appropriate shielding.
Electric current flows through the voltmeter that is spinning altogether with the rotating permanent magnet now. We can agree that velocity of voltmeter cannot have influence to that whether the difference of electric potential exists or not. Thus we can conclude that we have to measure the same voltage level in both cases of the

[5] Galileo Galilei, 1564 – 1642

experiments. But, somehow it is not true – in second case voltmeter will not measure any voltage at all!
The only logical explanation for origin of measured potential from first case is that voltage occurs in some reaction between static brushes and spinning magnetic field. The second one is that vortex field has influence in voltage generation in the device. The vortex field should exist in skin-deep layer around the contact between the brush and the disk. This experiment shell be repeated and carefully analyzed.
The origin of the potential and its explanation should lead as directly to the correct electromagnetic equations.
But let we consider how it is possible that so bad premise occurred: it seems that the origin of the conclusion is in observation of electric current running trough neutral electric conductors. The electric current in these conductors are consisted of holes and electrons and thus the moving observer cannot measure any relations between its velocity and electric current, i.e. it measures always the same current regardless its velocity. Let we analyze mathematically the following situation: an observer is moving near the infinitively long conductor and measures electric current:



The current is given by the following definition's formula:

$$I = \frac{dQ}{dt} \tag{6}$$

Whereas:

- I = electric current,
- Q = electric charge,
- t = time.

The following relation gives connection between electric current density and electric current itself:

$$I = \int_S \vec{J} \cdot d\vec{S} \tag{7}$$

Wheras:

- I = electric current,
- S = cutting surface of conductor,
- J = electric current density.

The electric current density is given by the following formula:

$$\vec{J}_o = \rho_e \cdot \left(\vec{v}_e - \vec{v}_o\right) + \rho_p \cdot \left(\vec{v}_p - \vec{v}_o\right) \tag{8}$$

Whereas:

- J_o = electric current density measured by observer,
- ρ_e = density of electrons,
- ρ_p = density of holes,
- v_e = drift velocity of electrons,
- v_p = drift velocity of holes, equal to zero in solid conductors,
- v_o = velocity of observer.

Equation (8) now becomes:

$$\vec{J}_o = \rho_e \cdot \vec{v}_e + \rho_p \cdot \vec{v}_p - \vec{v}_o \cdot \left(\rho_e + \rho_p\right) \tag{9}$$

We have also one more relation for metal conductors:

$$\rho_p = -\rho_e \tag{10}$$

Regarding relation (10) equation (9) becomes:

$$\vec{J}_o = \rho_e \cdot \left(\vec{v}_e - \vec{v}_p\right) \approx \rho_e \cdot \vec{v}_e \tag{11}$$

We can conclude that observer's velocity cannot have influence to it's feeling of magnetic field induced by infinitely long neutral conductor moving near.
The speed of holes is equal to speed of solid conductor because they are incorporated in crystal structure of the conductor.
Present formulas for force between two conductors do not include difference of currents and velocities of charges' carriers; furthermore they contain only currents' products. If we start from general formula for repulsion force between two moving charges it should be able to derive formula for force between two infinitely long pipes filled with two monochrome electrons' streams in which all electrons in a particular stream have the same velocity. The velocities of streams themselves could be arbitrary ones. Regarding the relativity of velocity and Maxwell equations general formula for force between two moving charges has to have the following form:

$$\vec{F}_{1,2} = Q_1 \cdot Q_2 \cdot \vec{f}\left(\vec{r}_{1,2}, \dot{\vec{r}}_{1,2}, \ddot{\vec{r}}_{1,2}\right) \tag{12}$$

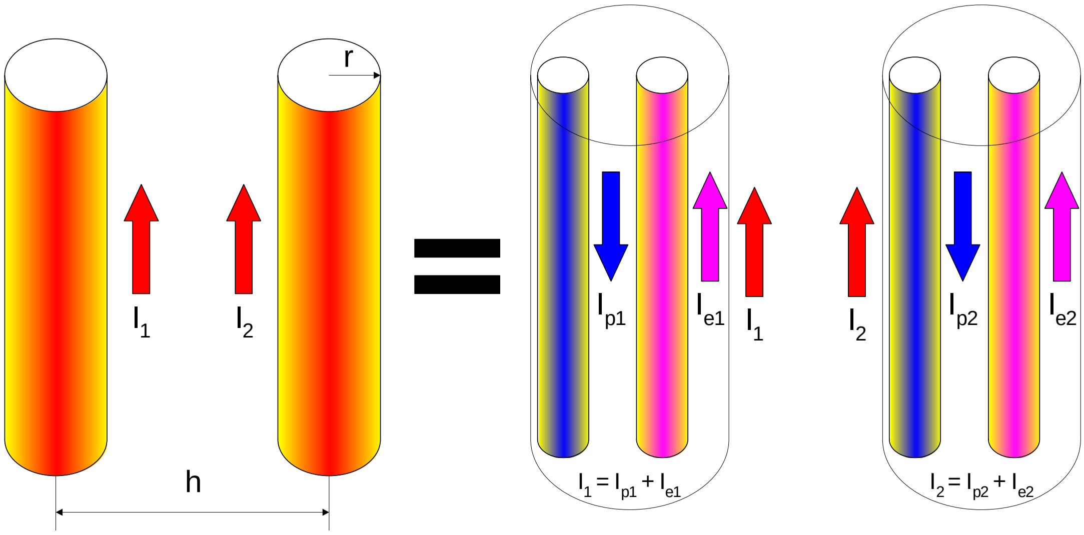
Where as:

$$\vec{r}_{1,2} = \vec{r}_2 - \vec{r}_1 \tag{13}$$

Regarding equation (12) general formula for force between two wires with currents becomes:

$$\vec{F}_{1,2} = \frac{I_1 \cdot I_2}{v_1 \cdot v_2} \cdot \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} \vec{f}\left(\vec{r}_{1,2}, \dot{\vec{r}}_{1,2}, \ddot{\vec{r}}_{1,2}\right) \cdot d\ell_1 \cdot d\ell_2 \tag{14}$$

I propose that start of searching for true set for formula for electromagnetic and relativistic phenomenal should begin with decomposition of every electrically neutral conductor into two pipes in which first one is filled with charges stream of electrons and second pipe is filled with holes' stream as it is shown on the following picture:



The current of holes interacts with the current of electrons and with the current of wholes in the other conductor. There is already shown earlier that the $\mathbf{I_p + I_e}$ is constant value regardless velocity of observer.
Regarding identity $\mathbf{I_{e1} + I_{p1} = I_1}$ we have:

$$\vec{F}_{1,2} = \vec{F}(I_{e1}, I_{e2}, v_{e1}, v_{e2}) + \vec{F}(I_{e1}, I_{p2}, v_{e1}, v_{p2}) + \vec{F}(I_{p1}, I_{e2}, v_{p1}, v_{e2}) + \vec{F}(I_{p1}, I_{p2}, v_{p1}, v_{p2}) \quad (15)$$

It is obvious now that general formula for force between two conductors has to contain currents' subtractions and addition too.
Let we derive approximate formula for force between two moving charged particles from the following well-known equations only:

$$\vec{E} \approx \vec{B} \times \vec{v} \quad (16)$$

The equation is derived from the following Maxwell[6] equation:

$$\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t} \quad (17)$$

And the other one is also well-known formula:

$$\vec{B} \approx \frac{1}{c^2} \cdot \vec{v} \times \vec{E} \quad (18)$$

Regarding (16) and (18) following formula is being derived:

$$\vec{E}_{ind} = \vec{E}_{=} + \vec{E}_{\perp} \approx \frac{(\vec{v} \times \vec{E}) \times \vec{v}}{c^2} = \frac{\vec{v}^2 \cdot \vec{E}}{c^2} - \frac{(\vec{v} \cdot \vec{E}) \cdot \vec{v}}{c^2} \quad (19)$$

[6] James C. Maxwell, 1831 – 1879. The equation was discovered at 1865.

Consequently:

$$\vec{E}_{tot} \approx \vec{E}_0 + \left(\frac{1}{c^2} \cdot \vec{v}_{1,2} \times \vec{E}_0\right) \times \vec{v} = \vec{E}_0 + \frac{\vec{v}_{1,2}{}^2 \cdot \vec{E}_0 - \left(\vec{v}_{1,2} \cdot \vec{E}_0\right) \cdot \vec{v}_{1,2}}{c^2} \tag{20}$$

Regarding above equation, approximate formula for force between two moving charged particles becomes:

$$\vec{F}_{1,2} \approx \frac{Q_1 \cdot Q_2}{4 \cdot \pi \cdot \varepsilon \cdot \left(\vec{r}_{1,2}\right)^2} \cdot \left(\left(1 + \frac{\vec{v}_{1,2}{}^2}{c^2}\right) \cdot \hat{r}_{1,2} - \frac{\vec{v}_{1,2} \cdot \left(\vec{v}_{1,2} \cdot \hat{r}_{1,2}\right)}{c^2}\right) \tag{21}$$

Whereas $\vec{v}_{1,2} = \vec{v}_2 - \vec{v}_1$. In appropriate geometry it becomes:

$$F_{1,2} \approx \frac{Q_1' \cdot Q_2' \cdot \ell}{2 \cdot \pi \cdot \varepsilon \cdot r_{1,2}} \cdot \left(1 + \frac{v_{1,2}{}^2}{c^2}\right) \cdot \hat{r}_{1,2} = \frac{Q_1' \cdot Q_2'}{2 \cdot \pi \cdot \varepsilon \cdot r_{1,2}} \cdot \left(1 + \frac{v_{1,2}{}^2}{c^2}\right) \tag{22}$$

Partial formula for magnetic force acting to conductor is obtained from the formula (22) only:

$$F_{1,2} = F_{1,2}\left(\Delta v_{1,2}\right) - F_{1,2}(0) \approx \frac{\mu}{2 \cdot \pi} \cdot \frac{Q_1' \cdot Q_2' \cdot \ell \cdot \left(v_2 - v_1\right)^2}{h} \tag{23}$$

$\Rightarrow$

$$F_{1,2} = \frac{\mu \cdot \ell}{2 \cdot \pi} \cdot \frac{Q_1' \cdot v_1{}^2 \cdot Q_2' + Q_1' \cdot Q_2' \cdot v_2{}^2 - 2 \cdot Q_1' \cdot v_1 \cdot Q_2' \cdot v_2}{h} \tag{24}$$

$\Rightarrow$

$$F_{1,2} = \frac{\mu \cdot \ell}{2 \cdot \pi} \cdot \frac{I_1 \cdot Q_2' \cdot v_1 \cdot \frac{v_2}{v_2} + I_2 \cdot Q_1' \cdot v_2 \cdot \frac{v_1}{v_1} - 2 \cdot I_1 \cdot I_2}{h} \tag{25}$$

$\Rightarrow$

$$F_{1,2} = \frac{\mu \cdot \ell}{2 \cdot \pi} \cdot \frac{I_1 \cdot I_2 \cdot \frac{v_1}{v_2} + I_1 \cdot I_2 \cdot \frac{v_2}{v_1} - 2 \cdot I_1 \cdot I_2}{h} \tag{26}$$

$\Rightarrow$

$$F_{1,2} = \frac{\mu \cdot \ell}{2 \cdot \pi} \cdot \frac{I_1 \cdot I_2}{h} \cdot \left(\frac{v_1}{v_2} + \frac{v_2}{v_1} - 2\right) \tag{27}$$

Regarding (15) we have:

$$\vec{F}_{e1,e2,p2} = \frac{\mu \cdot \ell}{2 \cdot \pi} \cdot \frac{I_{e1} \cdot I_{e2}}{h} \cdot \left(\frac{v_{e1}}{v_{e2}} + \frac{v_{e2}}{v_{e1}} - 2\right) + \frac{\mu}{2 \cdot \pi} \cdot \frac{I_{e1} \cdot I_{p2}}{h} \cdot \left(\frac{v_{e1}}{v_{p2}} + \frac{v_{p2}}{v_{e1}} - 2\right) \tag{28}$$

$\Rightarrow$

$$\vec{F}_{e1,e2,p2} = \frac{\mu \cdot \ell}{2 \cdot \pi} \cdot \frac{I_{e1} \cdot I_{e2}}{h} \cdot \left(\frac{v_{e1}}{v_{e2}} + \frac{v_{e2}}{v_{e1}} - 2 \right) + \frac{\mu}{2 \cdot \pi} \cdot \frac{I_{e1} \cdot I_{e2}}{h} \cdot \left(-\frac{v_{e1}}{v_{e2}} - \frac{v_{e2}}{v_{e1}} - 2 \right) \tag{29}$$

Whereas:

- I = electric current,
- Mr = specific molar mass of conductor,
- ρ = specific density of conductor,
- e = charge of electron,
- Na = Avogadro's constant,
- Val = number of free electrons per atom,
- S = surface of conductor.

The drift velocity is defined by the following formula:

$$v_{drift} = \frac{I \cdot Mr}{\rho \cdot e \cdot Na \cdot Val \cdot S} \tag{30}$$

HISTORICAL FORMULAS FOR FORCE BETWEEN CURRENT ELLEMENTS

It is a fact that perfectly true equation for force between two conductors is not known yet. Present physics tries to neglect existence of various formulas for the force. Furthermore there is a mathematical proof that all these formulas are correct, although it cannot be true because some of them have obvious absence of longitudinal force – the essential one for the electromagnetic interaction, like it is described with formula (14).

It will be listed here chronologically most important formulas for force between two conductors altogether with years of discovery.

Ampere[7] formula was discovered in 1823:

$$d^2\vec{F} = \frac{\mu \cdot I_1 \cdot I_2}{4 \cdot \pi \cdot \left|\vec{r}_2 - \vec{r}_1\right|^5} \cdot \left(3 \cdot \left(\left(\vec{r}_2 - \vec{r}_1\right) \cdot d\vec{r}_1\right) \cdot \left(\left(\vec{r}_2 - \vec{r}_1\right) \cdot d\vec{r}_2\right) - 2 \cdot \left(\vec{r}_2 - \vec{r}_1\right)^2 \cdot \left(d\vec{r}_1 \cdot d\vec{r}_2\right)\right) \cdot \left(\vec{r}_2 - \vec{r}_1\right) \tag{31}$$

This formula does not include longitudinal force.

The Grassmann[8] formula was discovered at 1845 follows now:

$$d^2\vec{F} = \frac{\mu \cdot I_1 \cdot I_2}{4 \cdot \pi \cdot \left|\vec{r}_2 - \vec{r}_1\right|^3} \cdot d\vec{r}_1 \times \left(d\vec{r}_2 \times \left(\vec{r}_2 - \vec{r}_1\right)\right) \tag{32}$$

It does include longitudinal force and thus it is first complete formula.

Derivation of the formula is very simple. Let we proceed with the following formulas:

$$d\vec{B} \approx \frac{\mu}{4 \cdot \pi} \cdot \frac{I_1 \cdot d\vec{r}_1 \times \vec{r}_{1,2}}{\left|\vec{r}_{1,2}\right|^3} \tag{33}$$

[7] Andre-Marie Ampere, 1775 – 1836

[8] Hermann Grassmann, 1809 – 1877

And

$$dF_{1,2} = dQ_2 \cdot \vec{v}_{1,2} \times \vec{B}_1 \tag{34}$$

And

$$dQ_2 \cdot \vec{v}_2 = I_2 \cdot d\vec{r}_2 \tag{35}$$

If we adopt that is:

$$\vec{v}_{1,2} = (\vec{v}_2 - \vec{v}_1) = \vec{v}_1 \tag{36}$$

Finally we have:

$$d^2\vec{F}_{1,2} = dQ_2 \cdot \left(\frac{I_2 \cdot d\vec{r}_2}{dQ_2} \times \left(\left(\frac{\mu \cdot I_1}{4 \cdot \pi} \right) \cdot \frac{d\vec{r}_1 \times (\vec{r}_2 - \vec{r}_1)}{\left|\vec{r}_2 - \vec{r}_1\right|^3} \right) \right) \tag{37}$$

That is actually formula (32). Regarding simplification done in (34), above formula is valid only for neutral conductors with equal valences.

Neumann[9] discovered his formula in 1850:

$$d^2\vec{F}_{1,2} = \frac{\mu \cdot I_1 \cdot I_2}{4 \cdot \pi \cdot \left|\vec{r}_2 - \vec{r}_1\right|^3} \cdot (d\vec{r}_2 \cdot d\vec{r}_1) \cdot (\vec{r}_2 - \vec{r}_1) \tag{38}$$

The formula does not include longitudinal force.
UFO researchers frequently cite Whittaker[10] formula discovered at 1903 although the formula itself is seldom cited in official handbooks of Electromagnetism at all:

$$d^2\vec{F}_{1,2} = \frac{\mu \cdot I_1 \cdot I_2}{4 \cdot \pi \cdot \left|\vec{r}_2 - \vec{r}_1\right|^3} \cdot \left(\left((\vec{r}_2 - \vec{r}_1) \cdot d\vec{r}_1 \right) \cdot d\vec{r}_2 + \left((\vec{r}_2 - \vec{r}_1) \cdot d\vec{r}_2 \right) \cdot d\vec{r}_1 + (d\vec{r}_1 \cdot d\vec{r}_2) \cdot (\vec{r}_2 - \vec{r}_1) \right) \tag{39}$$

Marinov[11] formula was discovered at 1993:

$$d^2\vec{F}_{1,2} = \frac{\mu \cdot I_1 \cdot I_2}{4 \cdot \pi \cdot \left|\vec{r}_2 - \vec{r}_1\right|^3} \cdot \left(\frac{\left((\vec{r}_2 - \vec{r}_1) \cdot d\vec{r}_1 \right) \cdot d\vec{r}_2}{2} + \frac{\left((\vec{r}_2 - \vec{r}_1) \cdot d\vec{r}_2 \right) \cdot d\vec{r}_1}{2} + (d\vec{r}_1 \cdot d\vec{r}_2) \cdot (\vec{r}_2 - \vec{r}_1) \right) \tag{40}$$

The above equation is only one that satisfies third Newton law, i.e. force between two current elements is equal in both directions.
All above formulas do not include velocity of charges creating electric current. Last two formulas were obtained by symmetrisation, by manipulation of electrical and magnetic potential and yet by Gauss law. Only S. Marinov showed certain suspicious about absence of velocity but he still had used officially adopted approach for derivation of his equation.

[9] Franz Neumann, 1821 – 1896
[10] Edmund Wittaker, 1873 – 1956
[11] Stefan Marinov, 1931 – 1997

HISTORICAL FORMULAS FOR FORCE BETWEEN TWO MOVING CHARGES

The other group of researchers tried to find correct formula of force between two moving charged particles. It is very interesting that these achievements were not directly used for evaluation of equations for force between two current elements.
Regarding Maxwell's equations we can conclude that the formula must contain second derivation of coordinate on time but however it is not the case with the present physics' official equations.
The equations will be listed bellow:

Gauss[12] equation is:

$$\vec{F}_{1,2} = \frac{Q_1 \cdot Q_2}{4 \cdot \pi \cdot \varepsilon \cdot \vec{r}_{1,2}^{\,2}} \cdot \left(1 + \frac{1}{c^2} \cdot \left(\dot{\vec{r}}_{1,2}^{\,2} - \frac{3 \cdot \left(\dot{\vec{r}}_{1,2} \cdot \hat{r}_{1,2}\right)^2}{2}\right)\right) \cdot \hat{r}_{1,2} \tag{41}$$

Regarding (12) above equation has absence of acceleration and absence of velocity collinear part of force vector, i.e. longitudinal force. Thus the equation is not the perfect one.
Weber[13] equation is:

$$\vec{F}_{1,2} = \frac{Q_1 \cdot Q_2}{4 \cdot \pi \cdot \varepsilon \cdot \vec{r}_{1,2}^{\,2}} \cdot \left(1 - \frac{\dot{\vec{r}}_{1,2}^{\,2}}{2 \cdot c^2} + \frac{\vec{r}_{1,2} \cdot \ddot{\vec{r}}_{1,2}}{c^2}\right) \cdot \hat{r}_{1,2} \tag{42}$$

The equation contains acceleration in the third addend that brings the equation above other ones. But, the equation does not contain longitudinal force component. However, Equation (42) is good approximation of correct equation.
Darwin[14] equation is:

$$\vec{F}_{1,2} = \frac{Q_1 \cdot Q_2}{4 \cdot \pi \cdot \varepsilon \cdot \vec{r}_{1,2}^{\,2}} \cdot \left(\frac{\left(\dot{\vec{r}}_1 \cdot \hat{r}_{1,2}\right) \cdot \dot{\vec{r}}_2 + \left(\dot{\vec{r}}_2 \cdot \hat{r}_{1,2}\right) \cdot \dot{\vec{r}}_1}{2 \cdot c^2} + \left(1 - \frac{\dot{\vec{r}}_1 \cdot \dot{\vec{r}}_2 + 3 \cdot \left(\dot{\vec{r}}_1 \cdot \hat{r}_{1,2}\right) \cdot \left(\dot{\vec{r}}_2 \cdot \hat{r}_{1,2}\right)}{2 \cdot c^2}\right) \cdot \hat{r}_{1,2}\right) \tag{43}$$

The equation also contains absence of acceleration although it seems to be much more accurate for the steady motion. It contains all components of vector fields like equation (21) including longitudinal force too.

ATTEMPT TO OBTAIN MORE ACCURATE FORMULA

Regarding equation (17) and its complement equation showed bellow:

$$\vec{\nabla} \times \vec{B} = \frac{1}{c^2} \cdot \frac{\partial \vec{E}}{\partial t} \tag{44}$$

We can conclude that formula for field is:

[12] Carl Friedrich Gauss, 1777 – 1855
[13] Wilhelm Weber, 1804 – 1891
[14] George Darwin, 1845 – 1912

$$\vec{\nabla} \times \vec{\nabla} \times \vec{E}_{ind} = -\frac{1}{c^2} \cdot \frac{\partial^2 \vec{E}}{\partial t^2} \tag{45}$$

$\Rightarrow$

$$\vec{F}_{tot} = -\frac{\mu \cdot Q_1 \cdot Q_2}{4 \cdot \pi} \cdot \mathrm{VECPOT}^2\left(\frac{\partial^2}{\partial t^2}\left(\frac{\hat{r}_{1,2}}{\vec{r}_{1,2}^{\,2}}\right)\right) \tag{46}$$

Whereas **$r_{1,2} = r_2 - r_1$**.

Total force can be described with following operator equation:

$$\vec{F}_{tot} = \frac{Q_1 \cdot Q_2}{4 \cdot \pi \cdot \varepsilon} \cdot \left(\frac{\hat{r}_{1,2}}{\vec{r}_{1,2}^{\,2}} - \frac{1}{c^2} \cdot \mathrm{VECPOT}^2\left(\frac{\partial^2}{\partial t^2}\left(\frac{\hat{r}_{1,2}}{\vec{r}_{1,2}^{\,2}}\right)\right)\right) \tag{47}$$

This equation could be simplified under certain circumstances:

$$\vec{F}_{tot} = \frac{Q_1 \cdot Q_2}{4 \cdot \pi \cdot \varepsilon} \cdot \left(\frac{\hat{r}_{1,2}}{\vec{r}_{1,2}^{\,2}} + \frac{1}{c^2} \cdot \Delta^{-1} \cdot \left(\frac{\partial^2}{\partial t^2}\left(\frac{\hat{r}_{1,2}}{\vec{r}_{1,2}^{\,2}}\right)\right)\right) \tag{48}$$

The equation is not accurate enough because it includes only first iteration of Maxwell's queue.
Equation (45) should be extended into following operators' queue:

$$\vec{E}_{k+1} = -\left(\frac{1}{c} \cdot \mathrm{VECPOT} \cdot \left(\frac{\partial}{\partial t}\right)\right)^2 \cdot \vec{E}_k \tag{49}$$

Solution of above equation is:

$$\vec{E}_{tot} = \sum_{k=0}^{\infty} \vec{E}_k = \frac{1}{1 + \left(\frac{1}{c} \cdot \mathrm{VECPOT} \cdot \left(\frac{\partial}{\partial t}\right)\right)^2} \cdot \vec{E}_0 \tag{50}$$

Regarding (50) force equitation is:

$$\vec{F}_{tot} = \frac{Q_1 \cdot Q_2}{4 \cdot \pi \cdot \varepsilon} \cdot \frac{1}{1 + \left(\frac{1}{c} \cdot \mathrm{VECPOT} \cdot \left(\frac{\partial}{\partial t}\right)\right)^2} \cdot \left(\frac{\hat{r}_{1,2}}{\vec{r}_{1,2}^{\,2}}\right) \tag{51}$$

Equation (45) can be simplified:

$$\Delta \cdot \vec{E}_{ind} = \frac{1}{c^2} \cdot \frac{\partial^2 \vec{E}}{\partial t^2} \tag{52}$$

Whereas $\Delta = \vec{\nabla}^2$.

Equation (50) becomes:

$$\vec{E}_{tot} = \frac{1}{1 - \frac{1}{c^2} \cdot \Delta^{-1} \cdot \left(\frac{\partial}{\partial t}\right)^2} \cdot \vec{E}_0 \qquad (53)$$

Regarding all above force equation becomes now:

$$\vec{F}_{tot} = \frac{Q_1 \cdot Q_2}{4 \cdot \pi \cdot \varepsilon} \cdot \frac{1}{1 - \frac{1}{c^2} \cdot \Delta^{-1} \cdot \left(\frac{\partial}{\partial t}\right)^2} \cdot \left(\frac{\hat{r}_{1,2}}{\vec{r}_{1,2}^{\,2}}\right) \qquad (54)$$

It is very difficult for operator's equations (51) and (54) to found explicit symbolic solutions. Approximate solutions can be found much easier but there is still question whether it would be correct enough because we are not still sure whether Maxwell equations are right or not although it is the most accurate set of equations in electromagnetic theory today. However, it has to be preceded with finding solutions of equations for force between current elements and then the solutions should be rigorously tested.

CONCLUSION

Regarding all above we can conclude that Maxwell equations may not be completely true because they include partial derivation on time and space and it is not in accordance with the statements just analyzed. The completely true equations should contain the drift velocity of charged particles. The velocity cannot be neglected in correct equations. Absences of these velocities directly lead us to the Lorentz[15] transformations, predecessor of Einstein theory of relativity that is not completely true due to evidential existence of serious discrepancy. See Boomerang project.

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[15] Hendrik Antoon Lorentz, 1853 – 1928