Similarities of the Motional Electric & Gravitational Forces

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Abstract

That the magnetic flux surrounding a current-carrying linear conductor moves with the electron drift velocity is demonstrated in a motional field out into the surrounding space. This field is not electrostatic. It is immune to shielding. Magnetic flux has been eliminated. The presence of this unique, special electric field is detectable and its intensity is measurable with an electrometer. From such measurements, electron drift velocities can be directly determined. The unique properties of this field strongly suggest its equivalence to the gravitational field. If equivalence proves to be a fact, then direct absorption of gravitational field energy becomes possible for electric power without pollution. If generation in great intensity becomes possible, theory indicates that the concepts of artificial gravity is space vehicles, weightlessness in limited earthly laboratories, and even anti-gravity, or lift instead of pull from the earth's gravity, have possibilities of attainment.

Introduction

How can a force like gravity originate and emanate from atoms of matter made up primarily of three elementary particles — electrons, protons and neutrons? Einstein wrote, "It would be a great step forward if we succeeded in combining the gravitational field and the electromagnetic field into a single structure" (1). A very considerable step in this direction may have been made by the advent of the recently invented motional electric field generator and the newly revealed properties of this field. (2)

When magnetic flux is moved perpendicularly across a conductor, we say that an emf is electromagnetically induced within the conductor. This phenomenon has been little thought of as involving the production of a spacially distributed electric field. It arises from the operation called flux-cutting; wherein the electric field is motionally induced within the space occupied by the moving magnetic flux, and is present therein, whether a conductor is present in this space or not. Correctly defined, we can say that when magnetic flux of vector intensity B is moved across a region of space with vector velocity V, an electromagnetically induced electric field of vector intensity $B \times V$ makes its appearance in this space, at right angles to both B and V. For short, this induced field is called a motional electric field. A study of its properties is exciting.

Clerk Maxwell wrote in his description of the work of Michael Faraday that the intensity of the induced electric field "is entirely independent of the nature of the substance in which it acts" (3).

The origin of this field, being electromagnetic induction, and non-electrostatic in nature, gives this field its penetrating nature which enables it to be present within either magnetic or non-magnetic conductors or insulators, entirely independent of the nature of the substance. The writer's extended experiments (4) involving shielding confirms Maxwell's description of this field.

The Motional Electric Field Generator

The motional electric field generator was designed and built to provide a device which would project a pure motionally induced electric field into the space surrounding it, devoid of electrostatic and magnetic accompaniments. It involves a newly discovered, non-mechanical method for moving magnetic flux, combined with one of the most basic and orthodox laws of physics, "the principle of superposition of fields". This principle states that in order to find the resultant intensity of the superimposed fields, each field should be treated as though the other is absent. The resultant is obtained by the vector addition of each field considered singly.

In 1820, Hans Christian Oersted discovered that a current-carrying conductor has magnetic flux looped about it. This discovery served to unify the then separate sciences of electricity and magnetism. In 1957, B.G. Cullwick (5), in a careful, thought-provoking analysis of moving charges, set forth three documented experimental fats to support the idea that the Oersted flux around a moving conduction electron should move with it. The writer had independently been led to the same conclusion. A plan for experimentally investigating this phenomenon was evolved. The design of the motional electric field generator was the result, and its production required the skill of an expert maker of generators and motors. This generator demonstrates and confirms that the Oersted flux actually does move with the electron drift velocity of the current giving rise to it. This discovery is a basic and fundamental contribution to electromagnetism. It also shows how this motion may possibly serve to explain the origin of gravitation from atoms of matter. The design of the generator itself will aid in seeing this possibility.

Momentarily, consider yourself in the place of a Maxwell demon, one who can see, from without, the planetary electrons of an atom orbiting about the nucleus. On the average, we may assume that there are as many going in one direction as in the opposite direction, in an approximate orbital plane. If these charges carry their Oersted magnetic fluxes with them, in the space surrounding an atom of matter, these moving fluxes will project an induced motional electric field, radially directed toward the nucleus.

The design of the motional electric field generator was such as to imitate in an elementary way the planetary electrons in an atom. The device involves no mechanically moving parts. It is wholly electrical.

The generator consists of 4020 insulated parallel linear conductors, ♯11, formvar insulated copper wire, nine inches in length, all connected in series and packed orderly side-by-side and tightly sealed together with epoxy into the shape of a solid, right circular cylinder. The series connections were accomplished by turning the wired through 180 degree angles without breaking the insulation. The two terminals connected to this composite of linear conductors are brought together at the axis of the cylinder and connected to a shielded and grounded two-wire cable. When energized by

a direct current, 2010 conductors are at any instant carrying current and magnetic flux vertically downward, and the same number of conductors are doing the same thing vertically upward. This composite cylinder is thus non-inductive with no measurable magnetic flux surrounding it. The principle of super-position of fields shows that each of the two sets of linear conductors contributes a motional electric field directed radially inward toward the axis of the cylinder. The superimposed magnetic flux from these two sets of conductors consists of horizontal circular flux loops, half directed clockwise and the other half counter-clockwise, half moving upward and half moving downward. Thus, we have a unique condition in the space surrounding the cylinder: the resultant magnetic flux, due to superposition of fields, is zero; and the resultant motional electric field intensity is $\vec{E} = \vec{B}_1 \times \vec{V}_1 + (-\vec{B}_1 \times -\vec{V}_2) = 2\vec{B}_1 \times \vec{V}_1$, or double the intensity attributable to one set of conductors alone, where $\vec{B}_1$ is the magnetic flux intensity due to 2010 linear conductors and $\vec{V}_1$, the electron drift velocity in, say, the positive upward direction. Although the magnetic flux energy in this device is reduced to zero, the electromagnetic induction giving rise to what we term the motional electric field has by no means been cancelled nor reduced.

The motional electric field is projected into the space surrounding our generator when the DC current therein is $30 amperes$, equivalent to that which would be associated with the uncancelled magnetic flux around a single conductor carrying a current of over $120,000 amperes$ ($4020 \times 30 = 120,600 ampereturns$).

Experimental Measurements

The motional electric field intensity is studied an measured by the use of a highly insulated, stainless steel cylindrical capacitor, placed around the generator, the inner cylinder of which is grounded and the outer cylinder is connected to the input head of a Keithley 640 Vibrating Capacitor Electrometer. A diagram of the circuitry employed in operating our generator is shown in Figure 1. The generator with its cylindrical capacitor about it is placed within a large grounded stainless steel cabinet. The vibrating capacitor electrometer head is also placed in the cabinet, close to the cylindrical capacitor, and connections are made to each plate. All connecting wires between the electrometer head and the galvanometer are electrostatically protected by grounded shielding. The electrometer galvanometer is outside the cabinet and has a grounding terminal for the whole electrometer system. The vibrating capacitor in the electrometer is energized by a small storage battery built into the electrometer galvanometer case. The inner capacitor cylinder, made of $\frac{1}{8}$" stainless steel, is insulated from the generator conductors by epoxy, and forms a partial housing. The epoxy covering the two ends of the generator is covered with a heavy coat of sprayed silver and this, with the inner capacitor cylinder, forms a completely grounded electrostatic shield around it. The motional electric field, caused by the up and down movement of the slowly moving (virtual) magnetic flux loops, induces an emf in the surrounding space and in the wire connected to the electrometer head and its ground connection. The capacitor plates are thus charged, the potential difference of which is registered by the electrometer galvanometer.

The potential difference is obtained by integrating the line integral of the electric field intensity $\vec{E}$ between the capacitor plates. It is given in mks units by:

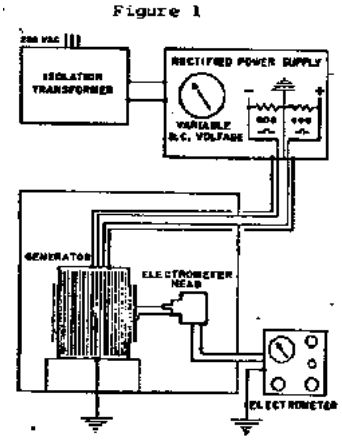

Figure 1: Diagram of Circuitry employed for generating & measuring the motional electric field.

$$P.D. = \int_{r_1}^{r_2} \vec{E} dr = \int_{r_1}^{r_2} \vec{B} \times \vec{V} dr = \int_{r_1}^{r_2} \frac{\mu_0 nIV}{2\pi r} dr \tag{1}$$

where $B = \frac{\mu_0 nI}{2\pi r} \frac{webers}{meter^2}$ and r_1 and r_2 are the distances respectively from the axis of the generator to the outer surface of the inner capacitor plate, and the inner surface of the outside capacitor plate. Thus, we have a typical example of how we can obtain the drift velocity $\vec{V}$, when $r_1 = 0.1meter$, $r_2 = 0.1035meter$, $\mu_0 = 4\pi \times 10^{-7}, n = 4020, I = 10amps, P.D. = 5 \times 10^{-6}volts$. Integrating (1), we have:

$$P.D. = \frac{\mu_0 nIV}{2\pi} \int_{r_1}^{r_2} \frac{dr}{r} = \frac{\mu_0 nIV}{2\pi} (ln(r_2) - ln(r_1)) \tag{2}$$

Solving for the drift velocity $\vec{V}$, we have:

$$V = \frac{2\pi P.D.}{\mu_0 nI} (ln(r_2) - ln(r_1)) \frac{meter}{sec} \tag{3}$$

$$V = 1.78 \times 10^{-2} \frac{meters}{sec} = 1.78 \frac{cm}{sec}$$

The classical derivation of the electron drift velocity is given by $\vec{V} = \frac{\vec{j}}{ne}$ where $\vec{j}$ is the current density ($j = \frac{10}{0.04172} \frac{amp}{cm^2}$), and n is the number of conduction electrons per cubic centimeter, and e is the charge on the electron ($1.6021 \times 10^{-19} coul.$). Using Avogadro's number, $N = 6.02252 \times 10^{23}$ for calculating, $n = \frac{dN}{M}$, where d is the density, $9.96 \frac{gm}{cm^3}$, and M is the atomic weight, $63.546 \frac{gm}{mole}$, for copper, we have:

$$V = \frac{239.69}{8.96 \times 10^{22} \cdot 1.6021 \times 10^{-19}} = 1.762 \times 10^{-2} \frac{cm}{sec}$$

A decrease of 100-fold in n, as indicated by Fermi-Dirac statistics would bring the experimental value of the same order of magnitude as the theoretical.

Measurements of electrometer potential differences $P.D.$ versus direct current values I, when taken quickly so as to prevent appreciable change in the temperature of the generator, due to electrical heat loss, yields a most interesting curve. Typical of most of the curves is the one shown in Figure 2. The magnitude of the motional electric field intensity will be seen to be directly proportional to the virtual value of the flux $\vec{B}$ involved, and hence to the current. The value of the electron drift velocity will also be directly proportional to the current. Thus the potential difference measured versus current values yield a parabola.

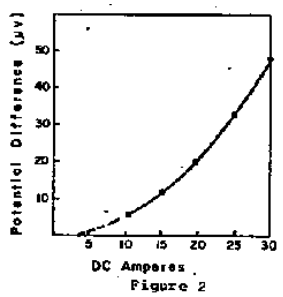

Figure 2: Capacitor Potential Differences measured as a function of DC current to the generator.

It is interesting to note that when alternating current values were plotted against electrometer deflections that a straight line was obtained instead of a parabola. This is illustrated in Figure 3.

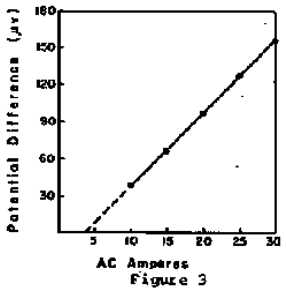

Figure 3: Capacitor potential differences measured as a function of AC current to the generator.

New Research Instrumentation

When improved and perfected, this motional electric field generator, together with a capacitor and an electrometer, appear to offer unique instrumentation for directly measuring the electron drift velocity in metals. Experimental values obtained with our generator are in good agreement with accepted values. Making measurements at various temperatures will afford a method of directly determining the quantity n, the number of free conduction electrons available per unit volume, thus affording an experimental check on the Fermi-Dirac statistics method for obtaining this quantity.

Crucial Experimental Evidence

It was, of course, necessary to run down every conceivable possible source of error. The question has been raised as to whether or not the potential difference electrometer measurements that we have observed as a function of input current to our device might arise from the thermoelectric effects instead of from the assumed $\vec{B} \times \vec{V}$ field. It is true that at $30 amperes$ input, approximately $3300 watts$ of electrical power is being poured into our device, and it heats up at this rate, perceptibly to the hand, in a time interval of four to five minutes. It has been suggested that the juncture between the copper wire and the inner cylinder of the capacitor might be raised in temperature more rapidly than the juncture on the outer cylinder and thus give rise to an observed emf. To examine such a possibility, we have made a series of measurements requiring only a few seconds for each reading. Starting with a $30 ampere$ input, we have gone down to 25, and then to 20, 15 and 10, then back up the scale in $5 ampere$ steps to 30 and again back down to $10 amperes$. The observed values of potential difference at each value of current were substantially identical. It does not seem reasonable to think that the innermost juncture could jump up and down in temperature values in a matter of seconds, permitting the electrometer galvanometer needle to return to its zero position immediately after each input value of current. When the device really warms up, each of the observed potential differences becomes enhanced and the plotted curves retain a nearly parabolic shape. We have, therefore, ruled out thermoelectric effects as giving rise to our observed measurements.

It has been suggested that possible non-cancelled magnetic fringing from the linear conductors acting on the innermost stainless steel cylinder might change the Fermi level of the metal and alter the contact differences of potential between the inner and outer cylinders of the capacitor. To eliminate this as a possible cause, a much larger diameter cylindrical capacitor was placed around the original one. The two plates of the first capacitor were grounded and measurements were made from the outermost capacitor alone.

The possibility that stray magnetic flux from the composite linear conductors, linking with the electrometer circuit, might give rise to the observed measurements was considered. A sensitive gaussmeter probe was employed to test for the existence of such flux. The maximum value found for such flux was of the order of half a gauss, found in one spot. To dispel all doubt, however, as to stray magnetic flux, a fairly large circuit, consisting of five wires was formed so that one side of the circuit came in radially from a distance of one foot to the central equatorial surface of the device, where it was held by tape and brought along parallel to the axis for several feet. This circuit loop was connected to a very sensitive microvoltmeter which was observed while various values of

input current up to 30*amperes* was sent into the linear conductors. No indication of an induced emf could be observed.

It is evident that the charging of the capacitor plates might possibly be due to charges carried by the current in the two wires leading onto the generator. If these wires are each at different potential differences with regard to the round, they carry an electric charge into the interior of the conducting housing enclosure of the generator and thus cause a charge of similar amount to appear on the outside of it and to produce a potential difference between the capacitor plates. This was experimentally confirmed by the inventor. When the generator housing was this raised to a positive potential difference with respect to ground, the electrometer deflections were to the right of center. When the housing was raised to a negative potential with respect to the ground, the electrometer deflections were to the left of center. These tests were made in two ways: (1) with no current flowing to the generator and (2) with current flowing, but one lead wire at a higher, or lower, potential with respect to ground than the other. Thus, it became evident that the two wires leading to the generator, with the grounded shielding, can be prevented from carrying a charge into the interior of the generator of the two wires are each constantly maintained at exactly the same value of potential difference above and below ground potential. A special power supply was built to provide this requirement. The voltage of each wire entering the generator was tested for various values of current and the potential differences were found to be accurately identical, above and below ground. Now, the deflections of the electrometer for various values of current were always to the right of center, indicating a electric field directed toward the generator was charging the plates. This field could not have come from a charge on the grounded generator housing with no net charge entering the generator, since such a possibility was carefully eliminated. Thus, the electric field must be due to the predicted $\vec{B} \times \vec{V}$ field. It is always directed toward the generator. This is a distinguishing characteristic of the $\vec{B} \times \vec{V}$ when it is due to the movement of electrons. If the current were due to the movement of positrons or protons, then the $\vec{B} \times \vec{V}$ field produced would be directed away from these currents instead of towards them! Alternating current thus produces electrometer deflections to the right of zero center the same as direct current, and this can be explained only in terms of the $\vec{B} \times \vec{V}$. Had the electrometer deflections been due to electrostatic charging, the electrometer needle would have remained under the alternating impulses, 60 times each second, when AC current was used.

The argument has been advanced that the movement of the magnetic field with the free as well as the orbital electrons in a piece of metal would result in a considerably inwardly directed motional electric field in the space all around this metal piece, contrary to experience. Our reply to this argument is that the motional electric field, thus undoubtedly built up in the space around the metal, is in fact the weak gravitational field emanating from it. True, it has never been detected as an electric field, and we claim that this probably is due to its very high composite frequency nature. We know from gravitational experiments that there exists just such an inwardly directed force around the metal. We know that it cannot be electrostatic nor magnetic. Yet, it does emanate from an aggregate of electromagnetic sources. We have good reason to believe that in view of the immunity of the motional electric field to shielding that this field could provide the field agency for gravitation.

Electromagnetic Induction With Zero B Is Not New

Our generator somewhat resembles a properly wound toroidal coil in that, in the same space outside such a coil, carrying current, we know that $\vec{B}$ is zero due to the principle of superposition of fields. We know that when alternating current is surging back and forth in its coils that a non-electrostatic, electromagnetically induced electric field is present continuously in this space around it, where the magnetic field intensity is continuously zero. The resultant magnetic flux energy in our generator is reduced to zero while the electromagnetic induction due to the movement of virtual Oersted flux, in each of the two vertical directions, gives rise to what we call the motional electric field in the space surrounding the generator.

A simple experiment can be performed to convince one that electromagnetic induction takes place in a space where the resultant magnetic intensity has been reduced to zero by superposition of fields. With soft iron sheet, form a cylindrical magnetic shield about a meter in length and a few centimeters in diameter. A stiff wire should be held centrally within the cylindrical tube, and both tube and wire moved horizontally in a North and South direction across the vertical component of the earth's magnetic field, while the two ends of the stiff wire are connected to a sensitive galvanometer. A deflection of the galvanometer needle will readily measure the induced emf produced within the shielded wire, where the magnetic field intensity has been reduced to zero. The wire was not in motion with respect to the shielding magnetic flux induced in the shield, but it was in motion across the earth's vertical magnetic component. Now, hold the stiff horizontal wire stationary and move the cylindrical shielding horizontally at right angles to its length a permissible distance, approximately that of its inside diameter. Again a deflection of the galvanometer will measure the induced emf within the stiff wire which was stationary with respect to the earth's field, but was cut by the magnetic field within the shield, which reduced the resultant field therein to zero. If accurately measured, the emf induced in the shielded wire will be found identical for the same movement when no shield at all is employed. In one case, $\vec{B} = 0$; in the other case, it is a real measurable value.

Mechanical Generation & Confirmation

The special distribution of motional electric field directed radially about the equatorial region of the generator was explored by means of a squirrel cage-like rotor, made up of parallel electromagnets all similarly directed so that, in some respects, it simulated the rotation of a unipolar magnet about its magnetic axis of symmetry. This apparatus is by no means such a magnet because its design is such to preclude a symmetrically uniform distribution of magnetic flux about its rotational axis. The rotation of this system of electromagnets affords an interesting experiment because here we have loops of magnetic flux of constant intensity completely filling the space about the rotor, all similarly directed from one end of the system to the other, and all in rotation about the same axis with the same angular velocity, and having a definite and constant flux pattern in space, not symmetrical nor uniform in the sense of a unipolar magnet though in a sense simulating one. That this magnetic field system rotates was readily demonstrated by means of a rectangular pickup coil placed close to the rotor and parallel to the array of electromagnets. When rotating at a speed of $10,000 rpm$ an AC voltage of $15 volts$ was obtained due to the humps of similarly directed magnetic flux which entered and left the coil. With a very sensitive zero-centered voltmeter, one could rotate the rotor by hand and demonstrate the rotation of the flux very visibly. A semi-cylindrical capacitor was

next placed over the top of the rotor, with two wires centrally and radially directed (from the rotor axis) to an electrometer. In this experiment, the wires from the capacitor plates to the electrometer are cut by the unidirectionlly rotating magnetic flux which induces the motionally induced emf in this space, and is detected and measured by the DC voltage to which the capacitor plates are raised. With this apparatus one can demonstrate that rotation of the rotor in one direction yields a radial inwardly directed motional electric field, while rotation of the rotor in the opposite direction reverses the direction of the motional electric field, thus demonstrating the vector nature of the field by changing the sign of $\vec{V}$ in the vector product $\vec{E} = \vec{B} \times \vec{V}$, and $-\vec{E} = \vec{B} \times (-\vec{V})$. By keeping a constant rotation and reversing the direction of the current to the electromagnets, the direction of $\vec{B}$ can be changed while $\vec{V}$ is held constant. In this manner the direction of the motionally induced electric field can also be reversed in the surrounding space and can be made either radially inward or radially outward as evidenced by the zero-centered galvanometer needle of the Keithley 640 vibrating capacitor electrometer which was used to make the DC voltage measurements. The demonstration that a spacially distributed motional electric field exists around either our mechanical or our all-electric generator appears to us to be amply demonstrated. To be more certain, however, we obtained the services of a disinterested expert in electronics measurements to come in and check our work with a sensitive Tectronic electron oscillograph, which confirmed our observations with the Keithley Electrometer.

Relation To Relativity

The question arises as to how this new field fits into the Relativity theories? It definitely provides an interesting clarification of a hitherto speculative deduction which many relativitists have ventured to make with respect to the $\vec{V} \times \vec{B}$ motional electric term which enters into the transformation equations of the Special Theory as applied to electrodynamics. It has been claimed that this $\vec{V} \times \vec{B}$ term is electrostatic in its fundamental nature. This conclusion is now definitely shown to be incorrect by the advent of the new motional electric field generator, the field of which emanates from a grounded conducting metallic container and passes readily through any shield. The non-electrostatic nature of the $\vec{V} \times \vec{B}$ has also been pointed out by Winch: "Notice that the $\vec{E}$ of ($\vec{E} = \vec{V} \times \vec{B}$) is not an electrostatic field intensity for it is not due to a distribution of charges" (6). Nature has definitely not limited us to one type of electric field. The motional electric field is different in origin and fundamental properties from the electrostatic field arising from charges.

The writer embraces the position taken by Sir James H. Jeans in his explanation of the Special Theory of Relativity and its bearing upon the two electric fields in the transformation equations. He points out that there is nothing in the postulates of the Special Theory that requires a physical interpretation of the two electric field terms $\vec{E}$ and $\frac{\vec{V} \times \vec{B}}{c}$ in the transformation equation $\vec{E}' = \left[\vec{E} - \frac{l}{c}\vec{V} \times \vec{B}\right]$. He states: "The equations may be taken merely as expressing relations between quantities as measured by the observer S and another S' moving with a velocity $\vec{V}$ relative to S" (7). Thus we see that there is no conflict with the Special Theory of Relativity. The philosophy of the Nobelist, P. W. Bridgman, whose "Operational Viewpoint" as set forth in his text, The Logic of Modern Physics (8), has guided the inventor in his work on this project. As Bridgman predicted, it has led to new and fundamentally basic knowledge.

That the gravitational field may possibly be identified as a motional electric field is at least very strongly suggested by the experimental work described herein. The claim of the General Theory of Relativity that the Gravitational field is equivalent to that of centrifugal force would appear to be a concept far removed form that of presenting it as a motional electric field. The experimental fact remains, however, that a pure motional electric field projected into space does simulate, in some respects, the gravitational field.

When the current flowing into this generator is constant, the motional electric field surrounding it is also constant and static, but not electrostatic, because it does not originate or terminate on charges. It readily passes through two $\frac{1}{8}$" thick sheets, or $\frac{1}{4}$" of stainless steel, constituting the cylindrical capacitor plates. The exciting thing about this generator is that it throws this $\vec{B} \times \vec{V}$ electric field out into the space around it. It is not electrostatic, not magnetic, and is immune to shielding. These properties make it a unique force in nature with possibly great utility to mankind.

Polarization & Absorption

Objects placed in this field are electrically polarized, and in making measurements of its intensity, the electrostatic fields arising from such polarization have to be reckoned with. From a well-known general theorem (9) we know that an intense convergent motional electric field would be attractive on any material object placed within it, due to this internal polarization. The recent experimental work of L. Brauner on the electric polarization due to gravity, is most interesting, as reported in the January 1969 issue of *Endeavor* magazine (10). His experiments convincingly show that the shoots and roots of plants when lying in a horizontal plane become electrically polarized. When turned into a vertical plane, this polarization soon disappears. Brauner presents excellent evidence in support of the conclusion that this phenomenon is due to the electrical nature of the earth's gravitational field.

This indicates in a limited way direct absorption of gravitational field energy. Of course, our hydro-electric plants are utilizing this energy in large quantities where advantageous sites for such plants can be found. The greatest potential inherent in the research described herein, the writer believes, will ultimately be in the direct absorption and conversion into useful electric power the vast reservoir of gravitational field energy which as yet has hardly been tapped. The insight into what we believe to be the mechanism within atoms which gives rise to the phenomenon of gravity, encourages us in the conviction that we can directly absorb and convert it to the service of mankind. Our research in this direction has commenced and is very encouraging.

Spacewise, this project has some speculative possibility, if and when this generated field can be made sufficiently intense. We have very considerable reason to believe that by the use of superconducting wire and liquid helium temperatures, this can be accomplished. To what extent is speculation at present, but theory would indicate that if intense fields are ever possible of generation, then the phenomenon of changing the weight of objects, and of even producing weightlessness and anti-gravity (that is, lift instead of downward pull on objects) would be possible.

Domestic and foreign patent applications covering the various generators and devies employed in our work have been field and some have been granted.

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