

Air Force Systems Command
Subject: Proposal for Development Plasma Probe
August 7, 1968

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Gentlemen:

For an investigation of plasma probe using energy transponder, direct energy converter, radioactive induced reactions as a means of measuring the flux of angle of incidents and energy spectrum of the inter-planetary plasma is enclosed. The Research Institute has been doing research only and wishes to become involved in the scientific aspects of a research project to investigate the feasibility and develop an energy analyzer, (which is used to determine ion and electron energy) spectra and give directional information about these fluxes. The mass analyzer will be on a dose rate which will provide information about the abundance of various elements which make up the inter-planetary plasma and the way these abundances vary with position, mass, time.

Objective: The objective of this experiment is to develop an instrument that will investigate the physical characteristics and the proposition of both the quiet time and the dispersed time characteristics of inter-planetary plasma. The aim of the experiment is to provide detailed information about the composition and energy distribution.

THEORETICAL APPROACH

This organization has determined by scientific investigation and experimental procedures that if the basic constituent material of a semiconductor is doped with an alloy which will sufficiently alter the mechanical and physical properties of the semiconductor, a definite micro structure is obtained that will produce a self annealing property to the basic material. Vital operating characteristics of the semiconductor are not changed by this doping. Thus, when the semiconductor is exposed to excessive radiation no injury to the particular operating characteristics of interest will occur.

This laboratory has for some years experimented with the concept of a "vacuum tube" using a semiconductor principle which makes use of a cold cathode and thereby many of the objectionable limitations inherent to high temperature cathodes are not apparent in this concept. Many of the mechanical sensitivities found in vacuum tube filaments are minimized. Leakage resistance is reduced and because of the effort toward higher purity of the material used in the doping of the semiconductor, greater sensitivity of operation is apparently obtained.

Combining these semiconductors with certain pressure and a plasma environment in these tubes arrangements, useful amount of energy may be obtained without the use of magnetic inducing materials so as to cut to a minimal all magnetic components.

The possibility of such an achievement has been examined by other investigators, and it has been shown to be feasible.^{1*} This semiconducting material, used in conjunction with a low-energy radioactive isotope, within a vacuum tube of particular design, and operated with properly designed oscillating or resonating electronic circuitry, is herein referred to as "Direct conversion, Electrical Power Cavity Resonator." It is anticipated that this arrangement might be transposed to become a device for measuring currents.

All objects at temperatures above absolute zero give off radiations and the lower the temperature the longer the wave length. Infrared detectors use either intrinsic or extrinsic semiconductors. Intrinsic detectors use electron transitions within the atoms that make up the semiconductor material itself. The extrinsic type utilizes electron transitions that occur due to the presence of impurity atoms introduced into the semiconductor material.

While the extrinsic materials permit detection of infrared radiations beyond 6 microns, these materials require temperatures below 40° K. This called for bulky, heavy apparatus and difficulty in designing into multi-element detectors. An intrinsic semiconductor that will detect photons in the longer wave lengths is not beyond the realm of possibility. In an intrinsic detector the more narrow the energy gap between the valence band 40° K, and the conduction band, the easier it is to excite an electron across the gap. Excitation may occur in two ways, by photon excitation and by thermal excitation. The problem is to synthesize a material with a gap narrow enough to respond to long wave lengths (i.e., low energy photons) yet wide enough that reasonable cooling temperatures will be sufficient to reduce thermal excitation.

Experiments at the Research Institute confirm our concept that our semiconductor vacuum and gas pressure efforts are the answer to energy transponders that will be capable of being both energy measuring and counting devices as well as energy converting devices.

A converter in which fission material is used for direct conversion to electrical power offers the greatest prospects for space application. Like the better known thermo-electric and thermionic direct conversion reactors, presently under development, a direct conversion system would have the advantage of no moving parts. It would operate with the benefit of passive components. Experimental evidence appears to show that

such materials will provide considerable amounts of energy, which energy could be used for manned earth-orbiting space stations.²

It is pointed out by Dr. George Safenev in ASTIA Document Number AD 144303 that "Experiments dating back to 1913 have generated electricity from charged particles emanating from nuclear disintegrations. To our knowledge, however, none of the past experiments have employed the fission process." We draw attention to the point that Sir Ernest Rutherford, James Chadwick, Ph. D., and C.D. Ellis, Ph. D., Fellow of Trinity College, Cambridge, referred to direct conversion as a means of identifying particles in 1899, while Dr. Gustave LeBon referred to it as early as 1897.

This proposal will also be concerned with an out-of-pile direct conversion electrical power system, making use of nuclear energy techniques as an integral part of a unique design. The proposal system will not make exclusive use of the currently 'popular' nuclear techniques now under investigation at many laboratories, as mechanisms for the achievement of a power source, which will meet the requirement of a suitable high power to weight ratio, outlined in the above referenced request for proposal. The major emphasis will be on a study of techniques of low energy excitation, derived from nuclear sources.

The proposed 'reactor' would be of minimal size. The system envisioned under this proposal will possess a power to weight ratio well below the one pound per watt in the lower power ranges and $\frac{3}{4}$ pound per watt in the upper power ranges. The duration of reliable power production will be from eight to ten years. Such a system will not develop tremendous temperature differentials, which must be accommodated by such large auxiliary devices as heat radiators, pumps, etc. For this reason it can be lighter and smaller than other direct conversion systems.

In the standard fission fragment converter, the cell has a very thin layer of fissionable material covering the surface of a cylindrical-shaped cathode. The anode is separated from the exterior walls by a vacuum gap and will act as a fragment collector.

The neutron bombardment occurs releasing fragments across the vacuum gap against the anode which acts as a fragment collector. These particles carry on the average about 20 positive charges, and the average kinetic energy is about 80 Mev. Continued open circuit operation should lead to the build up of an electrical potential of approximately 4×10^6 volts. By matching the load resistance to the internal fragment current, one can obtain any voltage below this value.

The proposal of this laboratory differs in the fact that the energy levels concerned are much lower and the original exciter does not require the use of damaging neutron bombardment. It is proposed that electrical energy be secured through the use of the phenomena of charge multiplication in a "properly" doped semiconductor material. The charge multiplication to be brought about by means of internal excitation derived from a suitable radioactive source. The semi-conductor material would form an integral part of a series of specially designed and constructed cold vacuum tubes. These vacuum tubes will operate in conjunction with specially designed electronic resonating circuits cutting down the electromagnetic effects by twisted silver-wired circuits and non-magnetic accessories which, experimental experience has demonstrated, will further enhance the effect sought and deliver appreciable amounts of usable power. We will designate this system as a direct conversion electrical power cavity resonator. This concept is the result of knowledge obtained in research in the field of what is commonly known as photo disintegration reactions; i.e., the reactions of alpha, beta, and gamma radiations in insulative or semiconductive materials.

The phenomenon of enhancing the flow or causing the flow of electrical charges in a semiconductor is not entirely unknown. Type A point contact transistors affect the property of current multiplication by factors of from two to three.^{*3} Experiments reported by the Field Emissions Corporation, McMinnville, Oregon, indicated that currents of several milliamperes can be induced by small dielectric components or insulators by means of certain radiations component parts such as chokes, inductances, transformers, etc., as used in this concept. It has been pointed out by A. J. Dekker in his book, Solid State Physics, that when germanium crystals, doped with donor impurities are irradiated with high energy particles, the conductivity decreases. Further irradiation may convert it from n type to p type and the conductivity may then be increased.

Present research in solid state semiconductors nuclear particle detectors has uncovered further evidence of current multiplication due to nuclear excitation. Materials such as cadmium sulfide display this property (sometimes referred to as internal amplification) and eliminate the need for associated electronics in their particular nuclear detector application^{*4}

Operation of such a device as herein proposed would entail a small temperature gradient. The direct conversion electrical power cavity resonator is designed to operate on a minimal amount of excitation energy (between 2.5 Mev to 8 Mev), thus the heat of reaction due to nuclear sources would be kept at a minimum. It is anticipated that the temperature gradient associated with the operation of this device would be several orders of magnitude smaller than that associated with that of the standard fission fragment converter. Due consideration will be taken of the temperature problem; though preliminary experiments indicate that this will not be a major difficulty.

The concept of direct energy conversion, which would allow the use of much lower energy levels of the original exciting particles, presents the inviting possibility of decrease in radiation hazards; decrease the excess of heat, and the need of eliminating waste heat by means of large radiators for cooling the reactor. It also allows a decrease size of the energy converter giving rise to a minimal amount of material for radiation protection. It would require a low-fuel inventory of inexpensive, readily available, radioactive materials, which would bring about further weight reduction.

Since there is little if any external neutron bombardment, damage done to the semiconductor material or internal structure from this source is essentially eliminated. To a large extent, this would increase the usability and lifetime of the material. It is recognized that a certain amount of damage maybe induced in the material under nuclear excitation. However, the damage from low energy level bombardment is certainly less than that reported in current studies of radiation damage. Furthermore, it is interesting to note that in Nuclear Electronic Effect Program, Ninth Tri-annual Technical Notes, published under contract AF33 (616) (6235) Project Number 1448-50965, dated 15 March 1962, that the annealing rate of recovery after a transistor was removed from a gamma cell was observed by the Bell Laboratories and that a definite indication was noted that a recovery could be increased (page 93, "Note the radically different time response of the different type of transistors). This is of considerable interest because if the annealing rate were sufficiently high, it might be possible to establish a dose rate threshold below which damage would anneal as fast as it occurred; and, therefore, it would not accumulate." This might be aided by building up a unit auxiliary circuit so constructed as to minimize the radiation effect.*⁵

We call attention to the fact that our preliminary research has lead us to make this proposal on this basis.

An oscillatory circuit excited by capacitance discharge through a semiconducting material would make the converter a pulse or digital device. The output of this circuit is used with a feed-back scheme in conjunction with the direct converter itself. This system, converter and associated circuitry, is obviously an A.C. type system, and operates at a high frequency allowing for better control and higher efficiency for the space application contemplated. We note that the output of a standard fission cell is a D.C. device.

It is proposed to pursue further research on a semiconductor direct energy converter that will use to its advantage the energies emitted by certain selected isotopes, in conjunction with a suitable semiconductor material especially doped with impurities which give rise to donor levels near the conduction band.

It is well known that, when an ionizing agent is absorbed in a semiconductor, the energy is almost entirely dissipated by excitation and ionization. It has been our observation that certain semiconductors we have been testing will suffer little or no gamma radiation damage to the important parameters governing the performance of the semiconductor in this application. The effects of gamma radiations on specially doped semiconductor material will result in the delivery of an appreciable amount of energy derived from the dissociation of radioactive material, and associated radiations, without the addition of supporting battery and other stationary or mobile sources of energy.

The effects of gamma irradiation on the saturated currents or reversed biased junctions of this and other material have been partially investigated.*⁶ Our research shows the effects of resistance to radiations depend strongly upon such factors as the molecular shielding of the doped non-magnetic metals to protect the lattice structure of the semiconductor material, that normally would be damaged by internal and external radiations, from such damage. We would also continue this study with a view for further understanding of the particular phenomena which are of dominant importance to the operation of the device under discussion in this proposal.

The passage of charged particles or gamma radiations through the semiconductor may cause extensive ionization and electronic excitation, but under the "shielding" effect of the doped impurities band, rupture is hindered with no damage to the performance of the semiconductor by radiation. These semiconductors should require no protection coatings which eventually may break down under radiation anyway.

The influence of ionizing radiation on the properties of semiconductor surfaces long has been recognized as a potential source of changes in semiconductor device parameters. Our experiences with our proposed doping material indicate detrimental changes should not occur from radiations or heat.

The preponderance of our experimental evidence indicates the entire crystalline structure of the semiconductor is involved and not just the surface. Therefore, further investigation would be directed toward such possible mechanisms as the Compton Effect, with particular emphasis placed on the scattered radiations, and the effects on the properties and operating parameters on the semiconducting material referred to above. Thus, we would consider the possibility that a device can derive energy for a direct conversion of electricity from a radiation environment through resonance absorption and re-emission.

To sum down the whole theory back of this proposal, it appears to be possible that a device can derive energy from a direct conversion of radiation through synchronized harmonic or resonating circuitry.

Thus, the application of these concepts and the derivation of energy for a direct conversion system is unique. The "generation" is accomplished by extensive exploitation of resonance or oscillatory principles rather than by conventional methods.

We do not believe that new physical laws are being advanced by this proposal. However, in recent research,*⁷ reference is made to difficulties associated with the operation of particle detectors owing to the appearance of low frequency oscillations, which the authors attribute to the interaction between deep traps within the semiconductor material, (cadmium sulfide). This evidence is indicative of a type of action which has

been under study for a considerable period by this laboratory.

We have had considerable experience in utilization of higher frequency oscillations which develop in our specially prepared semiconductor material.

This proposal envisions a device which will consist of a combination of specially designed and constructed vacuum tubes. We shall refer to these as "voltage transducers", and detectors and oscillators.

The vacuum tube voltage transducers are operated in conjunction with specially developed oscillating circuits which include high capacitance and provide a means through which the oscillating energy may pass to another specially constructed valve and its associated oscillatory circuit. The over all circuitry is arranged in cascade or series, that is, the first stage is followed by a second, third, etc... stages and these stages are essentially isolated from one another in such a way as to remove the possibility of unwanted feedback from one stage to another. Again, this technique of cutting down or blocking the undesirable feedback is a unique feature of this system. The oscillations which are set up in certain of the various oscillating circuits are deliberately coupled one with another by means of a type of automatic frequency control. Thus, this is essentially a frequency-modulated or frequency controlled pulse device.

Experimental work has indicated that amplification takes place from one stage to the next. The charging and discharging of the capacitors in the various stages of the circuitry is automatically controlled to conform with the fundamental frequency developed in the first stage. There is multiplicity of phenomena which occurs in this device which require further investigation. This further investigation must be conducted to determine the effect of gas ionization within the vacuum tube, the most desirable combination of semiconductor material and doping agents, more efficient resonating or oscillating circuits, and the possibility of irreversible radiation damage. The need, if any, for either biological or equipment shielding would be considered. Our experience, to date, indicates that the necessity for such shielding would be practically nil, in view of the small quantities of radioactive fuel required.

It is anticipated, in this effort, that a reaction may be induced in a solid state semiconductor material by a radiation stimulus which by either resonance absorption and/or excitation and in conjunction with certain electrical responding accessories will deliver energy in a direct conversion process. The possibility of inducing this release of energy in the solid state environment has been indicated by previous research devoted to the higher energy bombardment of particles by radioactive sources.

Whether this device operates by one type of radiation alone or not, is not currently understood by this organization. However, when an ionizing agent is absorbed in a semiconductor, the energy is almost entirely dissipated by excitation and ionization. This photo disintegration process could provide a source of the stimulus required. As we have indicated above, this would require further investigation. Our investigation up to date indicates that energy may be released under the scheme proposed at a moderate rate and without fission taking place. We are further led to believe by our investigations that difficulties associated with radiation damage will be minimal.

We wish to call attention to the fact and place considerable emphasis on the point that the above described conversion power supply system is the result of extensive research conducted at this establishment over a considerable period of time. That prototype or primitive working models have been designed, fabricated, and their operation demonstrated to competent observers. This organization is prepared to present evidence of this last statement.

We are certainly aware that all of the theoretical aspects of the proposed system are not complete and that some may be controversial; but, at the risk of repetition, the prototype models have been shown to operate as described. The theoretical discussion is presented only to show that the various concepts which possibly may be involved in the operation of this direct conversion electrical power system are at least plausible, and that the system warrants further investigation.

It is our firm conviction that this concept of a direct conversion electrical power supply possesses unusual merit, and that by this means we feel a highly efficient, relatively low-cost, high power to weight ratio 'power supply' can be created.

In as much as years of original research have been required in the above concept, we again declare that all this information is proprietary.

Our objective is to secure from a synchronized capacitance resonating hookup and special cold plasma vacuum tubes and other component parts, activated from radioactive sources in an ionized gas environment, an energy generator transponder which will be kept alive by the energies of the Universe.

It is not unscientific to maintain that by a process not unlike the Compton and Cebye premise, if the energy from the Universe is a scattered one, a distinct change may occur from the primary radiations and they will become concentrated in secondary radiations, showing not only the same frequency as in the primary source but also a long wave or lower frequency generated on the secondary side. These facts indicate that in the device herein proposed, "scattered energies" may be concentrated as in the Compton effect and the energy centered into a compact form and a distinct energy change will occur. There is a quantitative explanation for this which is based on a purely quantum phenomenon. If a primary

quantum of x-radiation energy strikes an electron it will impart to the electron a certain amount of kinetic energy resulting in a recoil. The radiation quantum is changed in its direction and consequently the wave length will be longer and can be made compact by repetition and still lower frequencies obtained.

Quantum theory on allowed energies arise in connection with harmonic oscillators and the results of many experiments which, together with the systematic and logical development of the quantum hypothesis, lead to the now accepted conclusion that all matter and energy is subject to quantum. This fact enables us to explain a wide variety of experimental data for which the results of conflicting classical theory are either wrong or ambiguous. The photoelectric effect, the Compton Effect, the energy levels of material systems, and the laws of governing the emissions and absorptions or radiations are examples.

To sum down the whole theory back of this research, it is possible that a device can derive energy from a direct conversion of electricity from radiation environments and from radiations of the Cosmos through synchronized harmonics and resonance.

This proposed device, combined with some special equipment, will consist of a combination of specially constructed tubes, which we will refer to as "pressure transmitters" and interceptors and oscillators.

Although no new laws of energy are being advance or claimed as having been discovered, the application in the method of utilization of the energy of the atom and throughout space is unique in that "generation" is accomplished by oscillatory utilization of radiation oscillations rather than by the conventional prime mover. These pressure transmitters have a synchronized pull with the specially developed oscillators of high faradic capacity and provide a means through which oscillating energy may pass to specially constructed valve oscillators which will permit energy to come into the detectors ad oscillators; automatic variable relation to the oscillations from the Universe and capable of setting up within their circuits initial oscillations which coincide and will be in resonance with the oscillations of the Universe.

In the dissipation of the charges created by the oscillations that continually accumulate, based on the oscillatory capacity back rush effect common to capacitors and herein applied to vacuum tubes, a useful energy will be obtained. The action of these devices, experiments have indicated, will have the fine effect of enlarging and prolonging the time of charging and discharging of the capacitors and the capacity energy in the circuit to an appreciable interval in perfect harmony with the radiations of the universe through the interceptors and oscillators in the circuit.

If we now introduce these electrons into a plasma control volume which contains numerous molecules, atoms, ions, and other electrons not controlled by a magnetic field (without even going into the details of attractive and repulsive forces, shielding distance, separation distance, etc...), the introduced electrons will experience many collisions with the plasma environment particles. Between a pair of collisions the path will be a straight line, but after each collision the introduced electrons will change in a random manner and the composite of these modes of motion will be a spiraling one.

To make our presentation more clear on plasma oscillations, let us consider electrically neutral plasma, one consisting of equal numbers of electrons and positive ions. Now let us further assume that the charged particles are arranged in some hypothetical equilibrium position. Actually, the particles will be in a constant state of agitation and thus the equilibrium state will be a time-averaged situation. Let us further assume that by some technique, the nature of which is immaterial, we displace these electrons from their equilibrium position and obtain surplus charges (actually it is not difficult to dislodge the electrons from their equilibrium position, whereas the ions which are more massive in size compared to the very tiny and mobile electrons, will be relatively stable in their original position). The displacement of the negatively charged electrons will give rise to local surplus of positive charges, which will then constitute an attractive force in beckoning back the departing electrons. This force imparts energy to the electrons, which now rush back but overshoot their original equilibrium position, giving rise to another inequality of positive and negative charges. The process thus repeats itself and the electrons oscillate about their equilibrium position. The frequency of these oscillations is called the plasma electron frequency. One can understand that the plasma frequency will depend on the type of plasma.

It should be noted that there is a distinct difference between electron oscillations in dielectric and in plasmas. In conventional dielectrics the electrons are bound to the atom and generally oscillate in phase with the applied force that causes the oscillations. In plasmas there are free electrons, and these oscillate out of phase with the applied force. Because partially ionized plasmas contain both bound electrons and free electrons, it follows that an applied electromagnetic field will have different effects on the species constituting the plasma. In treating electromagnetic wave propagation in various media, it is convenient to differentiate between the so-called phase velocity and the group velocity. The former refers to the phase difference between the vibrations at two points in a free plane wave or the velocity at which a point of

$$w = \frac{W}{k}$$

constant phase moves. It is defined $w = \frac{W}{k}$ However, it is also conceivable that changes in the amplitude of a train of waves may be brought about. In the parlance of the electrical engineer, we are speaking of a modulation impressed on the carrier wave. If the frequency of the carrier is ω and if the frequency of modulation is $\delta\omega$, then the resulting wave may be looked upon as a series of groups.

First, a plasma encountered in most engineering problems consists of a mixture of neutral atoms and/or molecules, electrons, and negative and

possibly even positively charged ions.

Two types of electrostatic oscillations are recognized. If in an electron-ion complex only, the electrons are permitted to oscillate, and the ions are assumed to remain stationary, one speaks of electron oscillations. If both the electrons and ions oscillate, then one speaks of ion oscillations. As a rule, the ion oscillations are low frequency oscillations and experimentally are comparatively difficult to recognize.

In considering electromagnetic wave propagation in plasmas, we should recapitulate the salient features of electromagnetic wave propagation in any medium. It is usually assumed that the plasma is a plane of finite thickness but otherwise infinite in extent.

Although the propagation of electromagnetic waves through plasmas subjected to applied static magnetic fields is quite complicated, the constitutive parameters may be derived.

Ionization is the process whereby one or more electrons are removed from the atom. Because this is an endothermic reaction, energy must be applied to the atom. Ionization may occur by virtue of a variety of mechanisms. Basically, these are all collision processes. However, we might categorize ionization mechanisms under three broad classifications; thermal ionization phenomena, which are due to the collision of agitated particles constituting the gas; ionization brought about by irradiation of the gas with high-energy particles; and cumulative ionization, which would combine a variety of processes.

In traversing through a plasma, the phase velocity of the propagation may exceed the speed of light in vacuo although the group velocity may be less than the light velocity. It no doubt has become evident to the reader that in this article, depth has been sacrificed in some instances for what we hope to be breadth, because a person who is familiar with the fundamentals and broad aspects of a subject can approach the solution in intricate problems with far more facility.

The combination of natural vibration and forced vibration is particularly important. It must be remembered that a point or resonance will be reached at some frequency and the charge will reach a magnitude depending on the impressed force which, in the case of the Universe, is immense, the fine effect of resonance.

The theory is that in perfect resonance, the oscillations will become more and more vigorous until the vibration or oscillation will maintain themselves. In this type of ionization, phenomena once initiated is self-sustaining.

With the multiplicity of vibrations corresponding to the natural vibration and pure resonance of the different substances composing this unit, self-sustaining is possible. Each substance had different pure ionic, pure vibration, pure resonance, referred to by way of comparison.

In pure resonance with certain electrical responding components and radioactive radiations which synchronize with the resonance of certain vibrations of the Universe, one will have usable energy from radiations.

This concept presents no new laws of physics. It may at first sight seem advancing further in the law of plasma generation, but careful investigation will disclose results obtainable which at first are not deemed possible. This is the history of science. Our concept poses greater ability of obtaining "saturation" and thus charges the accompanying capacitors at a more steady rate, and when a certain potential is reached, ionization occurs in the gases of the tube which cause the capacitors of the energizing circuit to discharge into other constituents of the circuit.

When ionization in the preceding tubes is no longer possible because of the reduced voltage, the process starts all over again. The first "valve" passes vibrations of energy into an oscillatory circuit, ionization sets in, a discharge occurs and energy passes through another "valve" into other oscillators. The process is repeated from the first stage on the second, on to the third, and so on.

The spectra of scattered rays are characteristic of the primary rays, and not of the secondary radiations, and show not only lines with the same wave length as those in the primary beam, but also on the long wave length side of these lines, other lines which indicate that in the process of scattering a distinct change has occurred. These modified lines can be quantitatively explained on the basis of a purely quantum phenomenon. A primary quantum of radiation energy $h\nu_e$ strikes an electron and imparts to the electron a certain amount of kinetic energy resulting in a recoil. The radiation quantum is changed in its direction and proceeds with an energy $h\nu$ smaller by the amount involved in the recoil of the electron. Consequently the wave length will be longer.

Each atom or particle is of itself a minute generator.

Radiation, in the oldest and strictest sense, is the process in which energy is emitted in accordance with the classical theory by a body in form of energizing waves possessing a frequency vibration transverse to the direction of the propagation.

This definition includes the energy associated with the energy radiation spectrum ranging from the highest energy (shortest wave lengths) of

secondary cosmic rays, gamma rays from radioactive disintegrations of atomic nuclei, x-rays, on down through ultraviolet rays, visible light, radio or Hertzian waves, and very long electric rays. All these waves, seemingly so different in methods of excitation and in their properties, even though the origin in all cases may be termed the unrest of electric charges, are actually identical in all respects except in wave lengths. All have the same velocity of propagation, all may be refracted, reflected, diffracted, and polarized, and are all properties of waves. In many other phenomena, however, these radiations manifest themselves as corpuscle quanta. The term "radiation" also includes energy emitted in the form of particles which possess mass. Without a media for propagation, there can be no motion, and without motion there can be no kinetic energy in the Universe or anywhere.

If we can consider two concentrated electric charges located even in dielectric of infinite extent, we have the picture of kinetic energy pervading all matter. Formulated symbolically, Coulomb's law is the rationalized MKS system (which brings all three energy concepts into the picture). Force is proportioned to the product of the magnitude of the charge upon the bodies. Force is inversely proportioned to the square of the distance between charges, if the material in which the charges are immersed is extensive and possesses the same uniform properties in all directions.

Force is dependent upon the material in which the charges are immersed.

The electric field viewpoint is of tremendous help in interpreting systems within which capacitances exist as a component part in a resistance capacitance relationship, producing an electric potential rise negative, to positive, and a potential drop from positive to negative.

Because of their small mass in "space", electrons subject to even a moderate accelerating field rapidly reach a very high speed. They enter the first stage at half the speed of light (in a vacuum). By the time they reach the second stage, at the billions of volts of the Cosmos, they are traveling at about .955, the speed of light in a vacuum.

In accordance with the theory of relativity, the mass of the particles increases with their velocity, and by the time they are within about one half of one per cent the speed of light, the rate of mass increase is extremely steep. At this electron voltage the mass is just about 40,000 times the "rest mass" and the electrons are traveling at almost constant speed and the subsequent energy gain appears primarily as an increase of mass.

This energy device is combined with some special equipment, and consists of a combination of specially constructed tubes which we will refer to as pressure traps and transmitters."

When energy radiation oscillating from a source is sustained by harmonic coupling in the device and very close synchronization to these energies is obtained, and the amplitude of the oscillations are increased to where they become powerful enough to operate a non-magnetic high frequency relay, the relay triples and the current flows over into the next stage, and the process is repeated over again on a greater energy scale and a powerful detector is energized. This might be called an amplifying monochromator. One of a special relay valve's functions is to prevent the energy from being permitted to create a back log. Another function of this unit is to center or focus the energy on a definite point in the vacuum which is why we call it a monochromator; a device used to focus rays or energy upon a definite point.

The preliminary valve keeps the energy from sinking back in a dead or non-kinetic stage. It is known that all atoms contain energy in a state of balance and it is necessary to throw it out of balance in order for it to deliver energy. The preliminary stage valve and amplifiers perform the following functions: the energy is brought in from the input oscillations of the energy from the Cosmos, started from the difference of potential between two radiating points (Suggested reference, solid state physics).

These energies are coming in through these tubes in place of the antenna and ground, and this preliminary stage valve and amplifier start the oscillations in this part of the circuit.

In the tuned amplifier and timer circuit of this first stage, there are the special capacitance for controlling the frequency and oscillations. The purpose of this is, resonance must be established and the resonance must be close to pure resonance as it is possible to obtain and maintain.

The preliminary stage valve tuned oscillator and amplifier will oscillate or recouple together with the others. This is accomplished in a regenerating circuit by returning energy from the plate to the grid, and then feeding it back again to the plates (All specially constructed vacuum units).

The energy going from the capacitance stage into the harmonic H.F. stage coupler was accomplished partly by the oscillators and valve tubes, and partly by the circuitry of the regenerated circuits. The object is to reduce the resistance to the very minimum.

At this point, a high frequency relay triples the energy into the second stage. At this stage the oscillations are so strong they might bum up the preliminary stage. The relay triples out the first stage and brings the second stage into primary use, and the second stage couples into the capacitance of the first stage. Through the relay, the energy by-passes the preliminary stage and is fed directly into the tuned oscillator amplifier circuit. The relay completes the circuit from the exciting oscillations coming from the excitation point to the tuned oscillator and from

the tuned oscillator to the capacitance and then from the capacitance to the harmonic coupler.

The harmonic coupler will then oscillate with the closed coupler and second stage valve and the capacitance.

From this point we go into the second stage. The action in the second stage valve oscillators, amplifiers and resonators is similar to what took place before in the first stage, only at a higher ratio of energy. The charging of these capacitors initiates the second stage oscillations. The oscillations are now strong enough to operate the second stage valve. This is accomplished by specially constructed tubes that oscillate in harmony with one another and are kept alive by the energy controlled by the larger valves. In this circuit the energy builds up through oscillations that are in tune with the radiating oscillations of the Universe.

At the risk of being repetitious, let us again say by a process not unlike the Compton and Debye premise, if the energy from the Universe is a scattered one, a distinct change will occur from the primary radiations and they will become concentrated under a suitable condition in secondary radiations, showing not only the same frequency as in the primary source but also a longer wave, and a lower frequency will be generated on the secondary side. These facts indicate that in the device herein described "scattered energies" may be concentrated as in the Compton Effect and the energy be centered into a compact form and a distinct change will occur. There is a quantitative explanation for this which is based on a purely quantum phenomenon.

If a primary quantum of x-radiation energy strikes an electron, it will impart to the electron a certain amount of kinetic energy resulting in a recoil. The radiation quantum is changed in its direction and consequently the wave length will be longer and can be made compact by repetition and still lower frequencies obtained.

Quantum theory on allowed energies arise in connection with harmonic oscillators and the results of many experiments which, together with the systematic and logical development of the quantum hypothesis, lead to the now accepted conclusion that all matter and energy is subject to quantum. This fact enables us to explain a wide variety of experimental data for which the results of conflicting classical theory are either wrong or ambiguous. The photoelectric effect, the Compton Effect, the energy levels of material systems, and the laws of governing the emissions and absorptions of radiations are examples.

To sum down the whole theory back of this proposal, it is possible that a device can derive energy from a direct conversion of electricity from the radiation environments of all adjacent sources through synchronized harmonics and resonance.

The action at this point is comparable to that in the previous stages; the energy being built up again by regenerative feed-back. Here the transformers are energized and the voltage is reduced and current increased from this stage to consecutive stages. These energy build-ups come not only from the continued tuned input oscillations, but from excitation of the entire circuit from all points maintained by the same primary radiating energy which excites the device.

Now the whole apparatus becomes the receptor of the environment energy. The energy in the circuits is fed back three times; it is in this third stage that we begin to transform.

The coupling resonator is considered part of the third stage amplifier. These same tubes act as resonators as they reamplify the oscillations. The tubes, therefore, have to be matched critically so they will be in perfect harmony or resonance with one another. The energy now passes through the high frequency output transformers.

After the energy leaves the primary transformer section and reaches the secondary transformer section, the frequency is again changed to overcome lagging and surges which were present in the first controlling circuit before reaching the conventional amplifier oscillator output.

In the next stage the delivery of the energy to the load is made.

After passing through certain fixed resistance, the energy is fed back on a "practically" conventional feedback principle. If we consider the phenomenon of negative resistance in the premise given below in a generic sense, we will recognize that the negative quality may be impedance or reactance rather than resistance.

The external manifestations of a negative characteristic are substantially the same in an A.C., H.F., and D.C. design; that is, the conduction curve has a negative slope over some part of it. In one instance, current (amperage) will be the independent variable; in another, voltage will be. As the h. f. current is increased, the h. f. voltage drop across the device first increases then decreases showing a negative resistance. Then as the applied h. f. voltage is increased, the h. f. current flowing through the device first increases and then decreases showing negative resistance. The coil and capacitor (L. D.) combination resonate at a frequency f , determined by the inductance and capacitance values. That is resonant frequency $f=1/(6.28 \sqrt{LC})$. Capacitance C is constant, but inductance L varies with the current, I , flowing through the circuit, so the resonant frequency changes the current (amperage). As the current increases, the inductance decreases, and f increases. This is the basis of this

operation.

The circuit behavior may be explained as follows: First I and C values are selected to give a resonant frequency somewhat lower than the generating frequency. As the current I increases, the inductance L decreases and tunes the circuit to the generating frequency and finally to a still higher frequency. Second, now as the current I is increased from zero, E rises and will continue to do so until the desired amperage is obtained when the specially constructed coils begin to saturate and the inductance is lowered and tunes the circuit toward resonance, the net reactance of the LC combination becomes theoretically zero at point one of the circuit; but at the other end E does not drop fully to zero because the resistance losses remain to act in the circuit after resonance cancellation of the reactance. At this the fourth step of this oscillatory stage, as I is increased, further coil saturation increases, inductance is further lessened and the circuit tuned to a frequency higher than the resonant frequency and the voltage once more rises.

The last tubes at the output section further smooth out the very last ripples or surges, and the energy activates the transformer, and is delivered to the output circuit where the amount delivered depends on how many stages have been used.

The whole device works on a radiating receptive principle, that is, "syphoning" radiations.

This presentation is based on high frequency phenomena and the use of high frequency units. The work spent in producing the electrification of a conductor is spent on the medium and stored there, probably as energy of motion. To denote this, we shall say that the medium around the conductor is polarized, this word being employed to denote that its state or some of its properties have been altered in some manner by the work done on it - that is, by the energy stored in it. In the case of the conductor possessing what is termed a positive charge, the medium around it is polarized in a certain manner and to a certain extent depending on the intensity of the charge. If the charge is negative the polarization is in the opposite sense. If we consider the case of a body charged alternately positively and negatively in rapid succession, the positive charge means a positive polarization of the medium, which begins at the conductor and travels out through space. When a body is discharged, the medium is once more set free and resumes its former conditions. The negative charge now entails a modification of the medium or polarization in the opposite sense. The result of alternate charges of opposite sign is that the medium at any point becomes polarized alternately in opposite directions; while waves of opposite polarizations are propagated through space, each carrying energy derived from the sources or agent supplying the electrification. Here then, we have a periodic disturbance of some kind occurring at each point, accompanied by waves of energy traveling outward from the conductor.

The phenomena of interference lead to the conclusion that light is the result of a periodic disturbance, or vibration of the medium, but as to the nature of the vibration-that is, as to the exact nature of the periodic change, or what it is that changes, we possess little knowledge. We know that alternating electric charges are accompanied by corresponding changes of state, or vibrations of the medium, and if the charge be varied periodically and with sufficient rapidity we have a vibration at each point analogous to, and perhaps identical with that which occurs in the propagation of light; a combination of wave and particle properties.

When capacitors are charged with energy and then discharged through a circuit of proper impedance, reactance and inductance, synchronizing the oscillations of the device with those of the source, we set up electrical inertia. That is, in the reversal of the current, the condensers are charged and discharged and recharged slowly until the energy originally stored in them is radiated in kinetic energy through the device, which is kept alive indefinitely by the oscillations of the Universe through establishing resonance.

Considering oscillations, mechanical and electrical and or (analogous to) mathematical, we find that electrical resistance is the same as mechanical friction and current comparable to mechanical velocity. Inertia and inductance then may be considered analogous terms. In mechanics, the greater the inertia of a body, the longer it will keep in motion. In this circuit, the greater the electrical inductance, the longer the current continues to flow, once it is established by a synchronized energy surge.

Expressed mathematically the equations are the same for electrical or mechanical phenomena. That is $R \geq \sqrt{\frac{4L}{C}}$ where R is the resistance in ohms; L is the inductance in henries, and C the capacity in farads. An oscillatory discharge will occur and with a very powerful inductance

inertia will assert itself. For low values of R, the frequency of the oscillations can be shown by $f = \frac{1}{2\pi\sqrt{CL}}$. The rapidity of the oscillations i.e., frequencies are governed by the quantity of the capacity and the inductance.

It is recognized that in addition to possessing kinetic energy, the atom is capable of absorbing energy internally. This internal energy would seem to be associated with the configuration of particles of which the atom is composed. While under ordinary conditions an atom is in what is known as the normal state, or the state in which we find matter apparently neither giving off nor absorbing energy. However, the internal energy of the atom can be altered. When the internal energy of the atom exceeds that of its normal state, it is said to be excited. Excitations may be caused in several ways, among which is the collision of the atom with rapidly moving positive or negative particles, as in the breaking of lines of force in the modern electromagnetic generator which is nothing more than an electron pump. An electric generator does not create the electrical energy any more than the water pump creates water. Kinetic energy is given up when excitation causes rapidly moving particles to

give up some or all of their kinetic energy to the atom during collisions.

Preliminary analysis of Explorer VI data shows the energy belts shrunk in size and in intensity-at least this was the state of affairs during August and September of 1960.

Another surprise came in the discovery of a third belt lying between the outer and inner belts found by Van Allen. Perhaps this new belt should be called the Arnoldy, Hoffman and Winckler belt, in honor of the three University of Minnesota cosmic ray scientists responsible for its discovery. These three physicists masterminded the construction of the radiation detection equipment which formed part of the payload of Explorer VI and analyzed the data it accumulated.

The new shape in radiation belts found by the Minnesotans confirmed a growing suspicion that the belts are not the stable pair of doughnuts once visualized, but a shimmering set of tenuous rings which may change markedly from day to day. Radiation levels measured by Pioneer III, Pioneer IV, and the Russian Mechta, and Explorer VI, have shown significant variations. Fortunately Explorer VI was in orbit and busily taking radiation measurements during a strong magnetic storm created by unusual activity on the face of the sun. As a result, the step-by-step reaction of the belts to such a storm, and a rather complete history of their return to normalcy was obtained for the first time. The orbit of Explorer VI was ideal in several respects for the probing of the intensity and extent of the Van Allen belts. Its orbit was highly elliptical, extending from about 4,100 miles from the earth's center at its near point to some 30,000 miles at its far point. Moreover, the inclination of the orbit was such that the rocket passed from rather high northern magnetic latitudes to high southern magnetic latitudes. Because of these two orbital characteristics, a large portion of the region of the belts was scanned in several days time.

That portion of the new data which has been processed to date indicates that the maximum normal radiation dosages in the belts during the period of August 7 to October 6 of 1960 was down significantly compared to that found earlier with payloads aboard Pioneer III and IV, and the Soviet Mechta. On the nights of August 16-17, 1960, a strong geomagnetic storm occurred which brought a new surprise. During the first 24 hours of the storm, about two-thirds of the radiation in the outer zone was "dumped" on the earth.

Available evidence suggests that the lost radiation consisted largely of low energy electrons. The outer belt soon recovered, in fact over-recovered, and near the end of the storm, on August 18, the outer-belt was found to contain about five times the total radiation found there before the storm.

This abnormally high radiation "fever" persisted for ten days and was followed by a slow return to normal. As far as we know, a satisfactory explanation of the "dumping" process in the radiation of the outer belt has not as yet been found.

Tracing the probable dumping paths of this radiation to earth, the Minnesota scientists found that it should show up near the surface of the earth between magnetic latitudes of 52 and 62 degrees, with a peak appearance at 57 or 58 degrees.

On the very night of the magnetic storm, the counters aboard Explorer VI revealed the disappearance of radiation from the outer belt; Dr. Winckler observed an aurora over Minneapolis at a magnetic latitude of 57 degrees. The tie-in was inescapable. The observed aurora must have been caused by the jumped electrons from the outer belt. Such electrons would produce more than the visible evidence of an aurora. They would produce x-rays. Previous observations by balloon had already indicated that such x-rays were often present at relatively low latitudes during times that visible auroras lay far to the north.

The Minnesota data thus gives support to the idea that, under certain conditions at least, an aurora may consist of two parts: a visible aurora most likely appearing near the usual auroral zone, and an x-ray aurora, invisible perhaps to the naked eye, lying to the south.

SPACE FILMS DISCLOSE FAR GREATER RADIATION

BEDFORD, MASS. (UPI) Film packs exposed at altitudes up to 700 miles in an Atlas nose cone showed far greater radiation than previously discovered, according to the Air Research and Development Command.

"Particle tracks indicate that radiation in the (Van Allen) belts, discovered by the Explorer satellites; far out shadow the flux of primary cosmic radiation as measured by means of skyhook balloons at 20-mile altitudes."

"Counts in the Atlas-flown emulsions show that for every cosmic ray that penetrated the block, some 44,000 protons of the Van Allen belt were recorded."

The accompanying photomicrograph of a section of the emulsion, smaller than the head of a common pin, shows a track produced by a heavy cosmic ray primary immersed in a sea of protons carrying kinetic energies in excess of four billion electron volts, and thus capable of penetrating the atlas nose cone."

"The more energetic of the trapped particles produced "stars" or nuclear explosions inside the emulsion (film) 500 times more frequently than observed on earlier Aerobee rockets which reached only 100 miles below the intense trapped radiation of the Van Allen belt."

If two molecules are beyond each other's molecular range and if the neighboring surfaces are, by any means electrified, the forces of cohesion could be intensified momentarily by something akin to chemical affinity, and cohesion would set in over Ultra molecular distances. The opposite charges cannot be maintained electrostatically between two neighboring metallic surfaces, but they can be momentarily imparted by a sudden jerk of disruptive discharge or receive electric impulses; these are the things which are effective in impulses, these are the things which are effective in promoting chemical cohesion. It is not to be supposed that the electrons in a polarized atom need to be disturbed in any great amount in order to produce chemical cohesion, polarization converts ordinary molecular force in cohesion into incipient but real chemical affinity.

In any collision between a charged particle and a neutral molecule, ionization takes place because of the electric force exerted on the planetary electrons in the molecules.

The Bohr Theory of spectral lines indicates that an electron should be able to lose energy to an electron in an atom or molecule as soon as it possesses an energy equal to $h\nu = \frac{1}{2} mv^2$; ν is the frequency of the energy radiated, h is the Planck constant, therefore we have $h = 6.62 \times 10^{-27}$ erg/sec, ν =frequency, m =mass. When the disturbed electron returns from its orbit or state, it was suspected that the first inelastic impact at increasing energies should correspond to these excitations losses, leading to light emission, and not ionization; the ionization potential being higher. It was found in complete conformity with Bohr's theory, the first inelastic impacts of electrons with atoms or molecules at lower energies, in general gives rise to the emission of light of the first line of a series of these atoms, and that as the electrons' energies increase, the separate higher lines of appropriate frequency appear as the energy reaches a proper value.

At an appropriate energy of the impacting electron, the atomic or molecular electrons are completely removed from the atoms or molecules leaving behind the positively ionized atomic ions or molecular ions.

When the electron possesses more than an ionizing amount of energy, any superfluous energy which it has after causing ionization is distributed between itself and some electrons removed from the atoms of molecules.

A single electron of appropriately high energy can liberate as many as 4 to 5 single electrons at once from an atom as in the outer electrons of mercury. The work of disassociation and the mechanism of ionization in certain gases such as the rare gases, nitrogen and hydrogen, has shown the possibility of the simultaneous excitation and ionization of the same atom by a single electron impact of appropriate energy.

Unless ionization occurs, atoms and molecules can absorb only discreet amounts of energy; this energy has the effect of moving the most loosely held orbital electron or electrons in an atom to some larger orbit.

Electrons of low velocity approaching an ionized atom or atomic ion or molecular ion, must be able to interchange velocities so that while one electron neutralizes the ionized atom, the other electron escapes with the total energy resulting from the process. Another example would be a free slow-moving electron approaching an excited atom; the energy of excitation is given to the slow electron while the excited electron returns to its normal orbit without radiation or to some intermediate orbit with radiation of lower frequency. A classical example for illustration is the irradiation of mercury vapor by the line 2537 Au; the mercury vapor becomes activated, is then in a metastable state; if these atoms collide with Thallium atoms while in this state, a thallium-electron would be raised to a higher level so that it emits the green thallium line. The difference between the energy of the 2537 Au line and the low-energy thallium is converted into kinetic energy of the separating mercury and thallium atoms after impact. If the activated mercury atom strikes hydrogen molecules in the excited state, the energy is converted into the work, a disassociation of these molecules into atoms or molecular hydrogen fragments. If the excited mercury atom collides with an atom of lower ionizing energy, this may remove an electron from the neutral atom ionizing it, and itself returns to the normal state.

Special provision is provided to stop the tubes from becoming blocked in their dissipation of the charges created by the oscillations that continually accumulate, based on the oscillatory capacity back-rush effect common to capacitors and herein applied in vacuum tubes. The action of these devices has the effect of enlarging and prolonging the time of charge and discharge of the capacitors and the capacity energy in the circuit to an appreciable interval in perfect harmony with the natural energy wave through the interceptor's valves and oscillators in the circuit which set up in the circuit electrical pulsations corresponding to the energy waves captured by the interceptor, and again kept from returning to the second outer circuit by "multi-walled" valves. The final tubes act as energy pressure transmitters with a means to prevent "shunting" condensation by a special form of "getter." This stops condensation from accumulating at the base of the tubes which would block their ionic action.

We have referred to a form of ionic action in place of the common electronic liberation accomplished in radio tubes. It is an accepted fact when various substances are bombarded with alpha particles, they are found to give off electrons. This is the principle involved in various vacuum tubes. Thomson gave a similar action of liberation the name of Delta Rays. These Delta Rays, or electrons, are thought by some to originate in a type of ionization which might be referred to as "thermions," given off when the alpha particles strike the bombarded substance. It is,

therefore, possible that some "particle" from the Cosmos with greater penetrating power than Alpha particles, can penetrate blown quartz, semiconductors, or various substances and set up a decided energy reaction.

Just as sodium, potassium, cesium, rubidium, barium, strontium, react to visible light, or let us say wave lengths, within a certain range, might not certain other substances or substance react to oscillations from the Cosmos and artificially produced radiations?

In some electronic tubes, the electrons are not emitted directly from the filament but from an indirect Cathode which does not enter into the direct electrical function of the tube, an indirect generation of energy (It is important that the reader understand that the tubes as described are cold cathode tubes using the principle of semiconductors).

The more perfect the ionic action, the greater the velocity. The greater the mean free path and the greater the collecting voltage, the greater the gain of energy will be between collisions and the greater amount of kinetic energy will be conserved. The collision will be "perfectly resilient."

The relationship and combination of natural vibration and forced vibration is particularly important. It must be remembered that a point of resonance will be reached at some frequency and the charge will reach a magnitude depending on the impressed force which, in the case of the Universe, is immense – in an effect of resonance.

The theory is that in perfect resonance the oscillations will become more and more vigorous until the vibration or oscillation will continue if properly maintained and controlled.

Solid state devices, we are convinced, can receive this energy in surges which may last only a few micro-seconds, but the pressure and the current in those surges are so large that sufficient energy is delivered to the equipment in resonance. Resonance and pressure can cause considerable amplifying of energy. Also the vibrations going out from the sources in the universe must also return to their sources.

These concepts present no new laws of physics. It may be a case of advancing further in a law and thereby obtaining results not at first deemed possible. This is the history of science. These radiating transducers possess greater ability to obtain "saturation" and thus charge the accompanying capacitors at a more steady rate which, when a critical voltage is reached, ionization occurs in the gases of the discharge tube and causes the capacitors of the detecting circuit to discharge into other capacitors and oscillators and the other component parts of the circuit. When ionization of the Plasma in the preceding components is no longer possible because of the reduced voltage, the process starts all over again. The first detector passes vibration of energy into an oscillatory circuit and ionization sets in, a discharge occurs and energy passes through another detector into other oscillators. The process is repeated from the first stage to the second, to the third, and so on.

Many phenomena, especially those occurring in certain frequencies, are still unexplained, and there are numerous places where the classic theory and observed facts seem to disagree.

When a vibration of any kind strikes a boundary between two media of different vibratory impedances at an angle of less than 90 degrees, a transformation of the vibratory rate may be changed into another vibratory rate. The device, therefore, will continue to capture energy by resonance, as long as the maintaining radiations of the sources continued to oscillate the various stages of detectors and amplifiers and oscillators of the circuit, a case of trapping of the energy which is everywhere present in the primary circuit and causing it to oscillate through the secondary circuits through a blocked circuit of no return.

Our experiments have proved that there is an energy which exists in the Universe which, by proper development of equipment, can be made available without a prime mover.

Energy was defined in 1892 as condition of matter, in virtue of which, any definite portion may effect changes in any other of definite portion. Later discoveries have since confirmed this. Energy then, is a state of matter, or rather, the result of a particular state or condition in which matter may be when any observed phase of energy appears.

Recognizing the fact that atoms can disassociate and reappear as energy and then from energy back to matter, then the question arises from whence do they obtain the immense quantity of potential energy necessary to launch into space particles with a speed of light or greater.

The explanation in reality is simple enough, since it is verified that far from being an inert thing only capable of giving up the energy artificially supplied to it, matter is an enormous reservoir of energy.

The problem of the nature of matter and of force is one of those which has most exercised the sagacity of scientists. Its complete solution has escaped us because it really implies the knowledge, still partially inaccessible, i.e., the first cause of things. Scientific theories heretofore set forth have not allowed us to completely solve this question. They lead, however, to a conception of matter and energy, far different from that of yesteryear.

Science has arrived at the conclusion that matter is an immense reservoir of energy solely constituted by a system of vibrating atoms maintained in equilibrium by the rotations, attractions, and repulsions of matter's component parts. From this equilibrium result the material properties or bodies such as weight, form, and apparent permanence. Matter also represents movement, but the movements of its component elements are confined within a very restricted space. This conception leads us to view matter as a variety of energy. To the known forms of energy, heat and light, there must be added another – energy from the cosmos which embraces but surpasses intra-atomic energy.

When the transformations of equilibrium are rapid, we call them electricity, heat, light, all forms of vibration. When the changes of equilibrium are slower, we give them the name of matter. To go beyond this we must wander into the region of hypothesis and admit that the elements of which the aggregate is represented by forces in equilibrium are constituted by vortices formed in the midst of the Universe. These vortices possess individuality, supposed by some to be ephemeral but which the evolution of matter and of energy prove to be otherwise. The individuality disappears, and the vortex dissolves as soon as the forces which maintain their existence cease to act; but others form elsewhere, i. e., eternal creation, eternal evolution, eternal energy, and some stages of matter.

The equilibriums of these elements of which the aggregate constitutes an atom, may be compared to those which keep the planets in their orbits. As soon as the equilibrium of matter is disturbed, considerable energies manifest themselves as visioned in beyond the microscope or beyond the telescope, their movements are similar.

Such disturbances in planetary systems may be realized, either without apparent reason, as in very radioactive bodies when, for diverse reasons, they reached a certain degree of instability, or artificially – as in ordinary bodies when brought under the influence of various excitants, light, or other forms of vibration or radiations.

We can only understand things by fitting them into the common frame of our thoughts. The essence of energy being unknown, we are compelled to materialize it in order to enable us to reason about it. We thus arrive, but only for the purposes of demonstration, at the following definitions: Energy and matter represent entities of the same order. It is through these manifestations that the Universe becomes known to us.

It is easy to deprive matter of all its attributes save one. Solidity, form, color, chemical properties may disappear, but there remains a rate of vibration. The very hardest body can be transformed into an invisible vapor. But in spite of every one of these changes, the mass of the body as measured by its weight remains invariable, and by changing or restoring rates of vibrations it can be made to re-appear; this constituted the one fixed point in the mobile ocean of phenomena, i.e., vibration. It enables the chemist, as well as the physicist, to follow matter through its perpetual transformations, and this is why matter remains something mobile and eternal.

The importance of permanence and, therefore, the indestructibility of vibration which one recognizes throughout the changes in matter, are the only characteristic by which this conception can be grasped.

The project as it is conceived is for the investigation of a plasma probe using an energy transponder direct energy converter, as described in the foregoing paper. It is felt by the author that the possibility of being able to develop a measuring device through the use of a "direct conversion electrical power cavity resonator," that was originally designed as a power source that was built to operate in harmony with the energy obtainable in outer space, is a feasible premise. This unit would be adapted to measure direction by command performance and mechanical configuration within the satellite itself. The energy spectrum, density of fluxes, and mass level, to be primarily, precalibrated, interpreted results.

All so-called vacuum "tubes" are of cold cathode quality using the principle of semiconductor reactions and have been designed as to overcome shock damage. These units are contained in envelopes that do not interfere with their function, and the vacuum level required, or the gas pressure required, are for enhancing the reaction of the material within the semiconductor elements of so called "tubes." The Research Institute is confident that this theoretical approach has greater flexibility for measuring plasma conditions with the interstellar space than any particle trap that might be designed.

¹ *Bell Telephone laboratories on behalf of Western Electric Company contract AF 33(616) -6235 Project 1448-50956 AD 278181, page 94.

² "Fission Fragment Conversion Reactors for Space," *Nucleonics*, April, 1963.

³ *Introduction to Solid State Physics by Charles Kittel, second edition, published by John Wiley & sons, 1956.

⁴ **Nucleonics*, April 1963, page 60, "Bulk Photoconductivity Detectors Suitable for Gamma Radiations

⁵ AD 278181 page 91

⁶ Technical Note, Published under contract AF33 (616) (6235) Project Number 1448-50965, dated 15 march 1962; Appendix E, pp. 73-114

⁷ April *Nucleonics*, "Bulk Photoconductivity Detectors Suitable for Gamma Radiations", p. 60.