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**CHAPTER:1 INTRODUCTION**

A burgeoning need exists today for small, compact, reliable, lightweight and self-contained rugged power supplies to provide electrical power in such applications as electric automobiles, homes, industrial, agricultural,recreational, remote monitoring systems, spacecraft and deep-sea probes.Radar, advanced communications satellites and, especially, high-technology weapons platforms will require much larger power sources than today's space power systems can deliver. For the very high power applications, nuclear reactors appear to be the answer. However, for the intermediate power range,10 to 100 kilowatts (KW), the nuclear reactor presents formidable technical problems.Because of the short and unpredictable lifespan of chemical batteries,however, regular replacements would be required to keep these devices humming. Also, enough chemical fuel to provide 100 KW for any significant period of time would be too heavy and bulky for practical use. Fuel cells and solar cells require little maintenance, but the former are too expensive for such modest, low-power applications, and the latter need plenty of sun.Thus the demand to exploit the radioactive energy has become inevitable high.

Several methods have been developed for conversion of radioactive energy released during the decay of natural radioactive elements into electrical energy. A grapefruit-sized radioisotope thermo-electric generator that utilized the heat produced from alpha particles emitted as plutonium-238 decays was developed during the early 1950's.Since then the nuclear power has taken a significant consideration in the energy source of future. Also, with the advancement of the technology the requirement for lasting energy sources has been increased to a great extent. The solution to the long term energy source is, of course, the nuclear batteries with a lifespan measured in decades and has the potential to be nearly 200 times more efficient than the currently used ordinary batteries.

These incredibly long-lasting batteries are still in the theoretical and developmental stage of existence, but they promise to provide clean, safe, almost endless energy.Unlike conventional nuclear power generating devices, these power cells does not rely on a nuclear reaction or chemical process and does not produce radioactive waste products. The nuclear battery technology is geared toward applications where power is needed in inaccessible places or under extreme conditions.

The NAG represents a new form of nuclear power conversion technology. It represents a smaller, safer and far more efficient than any conventional nuclear power generator now in existence. It can be used for virtually any power application from large to small hand devices. The other atomic batteries present in the market have not been able to achieve the efficiency or size reduction inherent in the NAG design. Atomic batteries possess isotope which is by far the most costly component. The unique design of the NAG allows it to use less isotopic fuel than any other atomic battery to produce the required power. It is alleged by Executive engineering that recent innovations in both materials and technology have made such devices feasible to generate both exceedingly large and exceptionally small amounts of electrical power and do it more efficiently ,with fewer breakdowns than conventional technologies now being utilised.

Currently, MEMS laboratory is utilising the advanced techniques necessary for the fabrication of NAG devices.The researchers envision its uses in pacemakers and other medical devices that would otherwise require surgery to repair or replace. Additionally,deep-space probes and deep-sea sensors, which are beyond the reach of repair,would benefit from such technology. In the near future this technology is said to make its way into commonly used day to day products like mobile and laptops and even the smallest of the devices used at home. Surely these are the batteries of the near future.

CHAPTER:2

**HISTORY**

The idea of nuclear battery was introduced in the beginning of 1950, and was patented on Mar 3, 1959 to Tracer lab. Even though the idea was given more than 30 years before no significant progress was made on the subject because the yield was very less.

A radioisotope electric power system developed by inventor Paul Brown was a scientific breakthrough in nuclear power. Brown's first prototype power cell produced 100,000times as much energy per gram of strontium-90 (the energy source) than the most powerful thermal battery yet in existence. The key to the nuclear battery is Brown's discovery of a method to harness the magnetic energy emitted by the alpha and beta particles inherent in nuclear material. Alpha and beta particles are produced by the radioactive decay of certain naturally occurring and man-made nuclear material (radio nuclides). The electric charges of the alpha and beta particles have been captured and converted to electricity for existing nuclear batteries, but the amount of power generated from such batteries has been very small. For instance, NAG technology would virtually eliminate dependence on conventional power sources such as fuel cells, solar cells, fossil fuel engines and diesel engines. Not only would the NAG eliminate all these sources of power but it would do it far less expensively than current technology allows.

Alpha and beta particles also possess kinetic energy by successive collisions of the particles with air molecules or other molecules. The bulk of the R&D of nuclear batteries in the past has been concerned with this heat energy which is readily observable and measurable. The magnetic energy given off by alpha and beta particles is several orders of magnitude greater than either the kinetic energy or the direct electric energy produced by these same particles. However, the myriads of tiny magnetic fields existing at any time cannot be individually recognized or measured. This energy is not captured locally in nature to produce heat or mechanical effects, but instead the energy escapes undetected.

Brown invented an approach to "organize" these magnetic fields so that the great amounts of otherwise unobservable energy could be harnessed. The first cell constructed (that melted the wire components) employed the most powerful source known, radium-226, as the energy source. The main drawback of Mr. Brown’s prototype was its low efficiency, and the reason for that was when the radioactive material decays many of the electrons where lost from the semi-conductor material. With the enhancement of more regular pitting and introduction of better fuels the Nuclear Batteries are thought to be the next generation batteries and there is hardly any doubt that these batteries will be available in stores within another decade.

**CHAPTER:3**

**ENERGY PRODUCTION MECHANISMS**

**BETAVOLTAICS**

Betavoltaics is an alternative energy technology that promises vastly extended battery life and power density over current technologies. Betavoltaics are generators of electrical current, in effect a form of battery, which use energy from a radioactive source emitting beta particles (electrons). The functioning of a betavoltaic device is somewhat similar to a solar panel, which

converts photons (light) into electric current.

Betavoltaic technique uses a silicon wafer to capture electrons emitted by a radioactive gas, such as tritium. It is similar to the mechanics of converting sunlight into electricity in a solar panel. The flat silicon wafer is coated with a diode material to create a potential barrier. The radiation absorbed in the vicinity of any potential barrier like a p-n junction or a metal semi conductor contact, would generate separate electron-hole pairs which in turn flow in an electric circuit due to the voltaic effect. Of course, this occurs to a varying degree in different materials and geometries.

A pictorial representation of a basic beta voltaic conversion is as shown in Figure 1. Electrode A (P-region) has a positive potential while electrode B (N-region) is negative with the potential difference provided by any conventional means.



Figure.1 Betavoltaic Technique

The junction between the two electrodes is comprised of a suitably ionisable medium exposed to decay particles emitted from a radioactive source. The energy conversion mechanism for this arrangement involves energy flow in different stages:



Figure.2 Various Energy States

**Stage 1 ~** Before the radioactive source is introduced, a difference in potential between two electrodes is provided by any conventional means. An electric load RL is connected across the electrodes A and B. Although a potential difference exists, no current flows through the load RL because the electrical forces are in equilibrium and no energy comes out of the system. We shall call this the ground state Eo.

**Stage 2 ~** Next, we introduce the radioactive source, say a beta emitter, to the system. Now, the energy of the beta particle EB generates electron-hole pairs in the junction by imparting kinetic energy which knocks electrons out of the neutral atoms. This amount of energy, E1, is known as the ionization potential of the junction.

**Stage 3 ~** Further the beta particle imparts an amount of energy in excess of the ionization potential. This additional energy raises the electron energy to an elevated level E2. Of course the beta particle does not impart its energy to a single ion pair, but a single beta particle will generate as many as thousands of electron-hole pairs. The total number of ions per unit volume of the junction is dependent upon the junction material.

**Stage 4 ~** Next, the electric field present in the junction acts on the ions and drives the electrons into electrode A. the electrodes collected in electrode A together with the electron deficiency of electrode B establishes a Fermi Voltage between the electrodes. Naturally, the electrons in electrode A seek to give up their energy and go back to their ground state (Law of Entropy).

**Stage 5 ~** The Fermi Voltage drives electrons from the electrode A through the load where they give up their energy in accordance with conventional electrical theory. A voltage drop occurs across the load as the electrons give up an amount of energy E3. Then the amount of energy available to be removed from the system is E3 = EB - E1 - L1 - L2

Where L1 is the converter losses and L2 is the losses in the electrical circuit.

**Stage 6 ~** the electrons, after passing through the load have an amount of energy E4. From the load, the electron is then driven into the electrode B where it is allowed to recombine with a junction ion, releasing the recombination energy E4 in the form of heat. This completes the circuit and the electron has returned to its original ground state. The end result is that the radioactive source acts as a constant current generator. Then the energy balance equation can be written as E0 = EB - E1 - E3 - L1 -L2

`Until now, Betavoltaics has been unable to match solar-cell efficiency. The reason is simple: When the gas decays, its electrons shoot out in all directions. Many of them are lost. A new betavoltaic device using porous silicon diodes was proposed to increase their efficiency. The flat silicon surface, where the electrons are captured and converted to a current, and turned it into

a three-dimensional surface by adding deep pits. Each pit is about 1 micron wide. That's four hundred-thousandths of an inch. They're more than 40 microns deep. When the radioactive gas occupies these pits, it creates the maximum opportunity for harnessing the reaction.

**SELF RECIPROCATING CANTILEVER**

The second possible nano-battery scheme, the self-reciprocating cantilever, is comprised of two components operating in cyclical manner. The central idea behind this oscillator is to collect the charged particles emitted from the radioisotope on cantilever. By charge conservation, the radioisotope will have opposite charges left as it radiates electrons into the cantilever. Thus an electrostatic force will be generated between the cantilever and the radioisotope thin film. The resulting force attracts the cantilever toward the source. With a suitable initial distance the cantilever eventually reaches the radioisotope and the charges are neutralized via charge transfer. As the electrostatic force is removed, the spring force on the cantilever retracts it back to the original position and it begins to collect charges for the next cycle. Hence, the cantilever acts as a charge integrator allowing energy to be stored and converted into both mechanical and electrical forms[4]. Figure.3 is a schematic of the self-reciprocating cantilever system

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Figure.3 Self Reciprocating Cantilever System

The distance between the cantilever and radioisotope is d and changes through the electrostatic build up and discharge cycle. The self reciprocating cantilever does not directly produce electric potential like betavoltaics but rather act as a charge integrator allowing energy to be stored and converted into both mechanical and electrical forms. Currently only macro-scale oscillators have been made but, just as betavoltaics, size is only limited by the ability to manufacture the various components.

**CHAPTER:4**

**FUEL CONSIDERATIONS**

The major criterions considered in the selection of fuels are:

 Avoidance of gamma in the decay chain

 Half-Life

 Particle range

 Watch out for (alpha, n) reactions

Any radioisotope in the form of a solid that gives off alpha or beta particles can be utilized in the nuclear battery. The first cell constructed (that melted the wire components) employed the most powerful source known, radium-226, as the energy source. However, radium 226 gives rise through decay to the daughter product bismuth-214, which gives off strong gamma radiation that requires shielding for safety. This adds a weight penalty in mobile applications. Radium-226 is a naturally occurring isotope which is formed very slowly by the decay of uranim-238. Radium-226 in equilibrium is present at about 1 gram per 3 million grams of uranium in the earth's crust. Uranium mill wastes are a readily available source of radium-226 in very abundant quantities. Uranium mill wastes contain far more energy in the radium-226 than is represented by the fission energy derived from the produced uranium.

Strontium-90 gives off no gamma radiation so it does not necessitate the use of thick lead shielding for safety. Strontium-90 does not exist in nature, but it is one of the several radioactive waste products resulting from nuclear fission. The utilizable energy from strontium-90 substantially exceeds the energy derived from the nuclear fission which gave rise to this isotope.

Once the present stores of nuclear wastes have been mined, the future supplies of strontium-90 will depend on the amount of nuclear electricity generated. Hence strontium-90 decay may ultimately become a premium fuel for such special uses as for perpetually powered wheel chairs and portable computers. Plutonium-238 dioxide is used for space application. Half-life of Tantalum180m is about 1015 years. In its ground state, tantalum-180 (180Ta) is very unstable and decays to other nuclei in about 8 hours but its isomeric state, 180mTa, is found in natural samples. Tantalum180m hence can be used for switchable nuclear batteries.

CHAPTER:5

**MAIN FUELS**

* Nickel-63 (Ni-63)
* Strontium-90 (Sr-90)
* Promitium-147 (Pm-147)
* Uranium-238 (U-238)
* Tin-121 (Sn-121)
* Uranium-235 (U-235)
* Tantalum-180 m



Figure.4 Prototype car model using NAG by Ford Motors



Figure.5 NAG Fuel Source Model



Figure.6 Proposed Model Of NAG



Figure.7 Internal Structure of NAG

CHAPTER:6

**ADVANTAGES**

**FUEL SOURCE-**

Since isotopes are the fuel of all Nuclear Accelerated Generators, a quick note about radioactive isotopes is in order. Radioactive isotopes are continuously being produced as part of radioactive waste. Current estimates place the amount of such waste in United States at over 100 million gallons. They are being stored in temporary tanks, at underground sites at great expense to tax payers and serious hazard to the environment because till date there has been no discovery of large scale practical uses of them .Isotope production at existing level costs less than the current cost of fuel. With numerous half lives of many isotopes and trade-in values factored in, the cost advantage of the isotopic fuel is even more pronounced. As the demand for isotopes inevitably grows, the costs associated with their production will only decrease.

Once placed as fuel into a NAG, these radioactive fuels could theoretically last from approximately three years to more than 400 years before they need replacement. Additional, outside electrical power is not required. The NAG is completely and totally self- sustaining. Further, due to unique design of the NAG, there is virtually no danger of meltdowns and absolutely no danger of explosions or other catastrophic incidents. The device can stop working or can be shut down for maintenance with no danger to personnel, the environment or nearby population centres'

The fuel source of the Nuclear accelerated generator is a radioisotope. There are many different isotopes that can be used as a power source for the NAG. Pure Beta emitters work best in the device and will extend the device’s life longest. Included in this list would be such isotopes as NI-63, SR-90,PM-147 and SN-121m. All appear to have the ideal properties for the production of power. Assuming an active lifespan of three to hundred years, most isotopes would have atleast 10 half lives worth of useful energy discharge .Nuclear isotopic power will bring to fruition such things as particle beam weapons, ion-powered space planes, nuclear powered jet aircraft, high powered laser canons, nuclear powered tanks, nuclear powered naval ships and even cryogenic coolers.NAG devices can also be easily adapted to power large metropolitan areas, forward military bases and other applications where dependable power is needed in remote areas. The NAG device can perform these functions cheaper and more efficiently than current technology.

**OIL DEPENDENCY-**

If a significant portion of generating capacity was switched to the devices using NAG, a large percentage of foreign oil dependence could be eliminated. This, in turn, could lead to a steady decrease in the price of fossil fuels, including oil and gas. Estimates vary on how many years the world’s oil reserves will last but it is admitted by everyone that the amount of reserves is finite and will eventually run out. The NAG is one of those generating devices which can bridge the gap both to delay the depletion of oil reserves and to take over when they eventually run out.

**SAFETY-**

It is asserted by Executive engineering that there are several other significant attributes that make the NAG far safer than conventional facilities. To begin with, the NAG needs no large scale containment or special shielding. The NAG has absolutely no external emissions and produces no contaminated steam that can leak. It also produces no nuclear waste on its own. On the contrary it utilizes nuclear waste for its own fuel. Also, the NAG cannot produce any contaminated water since no water ( or any other liquid) comes in contact with the nuclear material. The nuclear fuel for the NAG is solid and there are no rods that need to be adjusted to produce different power levels. Lastly, and possibly the most important, the radioactive isotopes that power the NAG do not need to be cooled. The NAG is not a heat producing device as is the conventional nuclear facility. One gram of Strontium 90 (a potential and likely fuel for the NAG) can produce 10,000 watts of power and heat.

**ADAPTABILITY-**

Perhaps the most important aspect of NAG is its adaptability to widely differing applications, both civilian and military. For instance, this device should easily be able to handle the electrical generating tasks for large metropolitan and rural areas alike. However, this technology is truly scalable and there should be no problem adapting it to power other things as well which can include virtually any ship in the Navy. This implies that fleets of ships could sail for years without needing to refuel. The small size of the NAG should make it feasible to replace existing ships with this new power supply. Executive engineering also believes that versions of the NAG could be made to power other large military vehicles such as tanks and armored personnel carriers.

It is suggested that tanks fitted with NAG power supplies could run for years without the need to worry about expensive and cumbersome fuel re-supply efforts. Other military uses could include the ability to parachute smaller NAGs directly into the field to supply the power needs for forward military bases, military hospitals and other such needs, all without the need for fuel/ fuel tanks/ trucks.

Civilian uses could include instances of disaster relief in such cases where large areas of land could have been devastated by natural disasters such as floods or earthquakes. NAGs could be transported or dropped in to provide quick, efficient power for relief teams.

Unlike conventional devices, NAG can work under a wide range of external conditions ranging from many degrees above zero to many degrees below zero. Simply put, this device should work equally well in the Antarctic or the Sahara.

The isotopic fuel of the NAG can easily be transferred from one device to another allowing for quick transfer and minimal loss of power. For instance, if an NAG were to become damaged for one reason or another, the old/ damaged one could be unhooked from the device, and a new one attached with very little effort, even in the field.

**COST/EFFICIENCY-**

There are other advantages of using radioactive isotopes as fuel. Since the availability of the atomic isotopes is more than ample, costs of this fuel should be considerably less than either conventional atomic fuel or fossil fuel. Further, since the casement of the NAG is not very expensive, the cost of replacing damaged and/ or broken parts is quiet small. It is relatively a low cost replacement device.

**POWER OUTPUT-**

It is further asserted that this NAG technology could produce 30-50 times more than conventional nuclear technology. This has already been proved in experiments. This could mean that a given amount of power, a facility could be built far smaller than existing nuclear or fossil fuel power plants.

It is admitted that much of this sounds too good to be true but Executive Engineering has been able to convince that this device, although totally new in concept, is based on hard science and can be developed to produce exactly what is claimed. It is firmly believed that research will bear out each and every one of the statements made on its behalf.

**RADIOLOGICAL DAMAGE-**

There is no such thing as a safe isotope as even a few molecules of a particular isotope over a long time can be damaging. From the perspective of a conventional nuclear power plant, however, a NAG is one of the safest devices on the planet. The device is self contained with little or no X-rays whether in operation or not in operation. Beta particles are never emitted outside the casing of the device.

There are some isotopes that do emit Gamma radiation and in such cases it may become necessary to add shielding for the Gamma rays. Most of the isotopes being considered for the NAG devices do not emit Gamma rays. The only possible way it can be harmful is if a person would pry the device open and breathe from inside it. A distance of two to ten feet from the device is quite sufficient to protect personnel from danger even if it were to be shot open or exploded. The only danger would be if the isotope actually entered a person’s body or came in prolonged contact with the skin.

**REPAIR AND MAINTENANCE-**

It is reasonably expected that both these NAG devices should have a 10-year life span after which time the nuclear source would be removed and replaced. It is an easy task to replace either the nuclear source or the Power core. Generally, it is expected that over the five to ten year life span, the power core will be damaged from the constant bombardment of Beta particles and would need to be replaced. Unlike current RTG’s, a NAG device does not require the source to be in contact with the walls of the device. The source is mounted in the middle and the removal and re-insertions is an easy task requiring very little time or effort. The exchange would involve a snap-in/snap out operation using safety procedures to ensure correct operation.

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**CHAPTER:7**

**DRAWBACKS**

First and foremost, as is the case with most breath taking technologies, the high initial cost of production involved is a drawback. But as the product goes operational and gets into bulk production, the price is sure to drop. The size of nuclear batteries for certain specific applications may cause problems, but can be done away with as time goes by. For example, size of Xcell used for laptop battery is much more than the conventional battery used in the laptops.

Though radioactive materials sport high efficiency, the conversion methodologies used presently are not much of any wonder and at the best matches conventional energy sources. However, laboratory results have yielded much higher efficiencies, but are yet to be released in to the alpha stage.

A minor blow may come in the way of existing regional and country specific laws regarding the use and disposal of radioactive materials. As these are not unique world -wide and are subject to political horrors and ideology prevalent in a country, the introduction legally requires these to be scrapped or amended. It can be however hoped that, given the revolutionary importance of this substance, things would come in favour gradually.

Above all, to gain social acceptance, a new technology must be beneficial and demonstrate enough trouble free operation that people begin to see it as a “normal” phenomenon. Nuclear energy began to lose this status following a series of major accidents in its formative years. Acceptance accorded to nuclear power should be trust-based rather than technology based. In other words, acceptance might be related to public trust of the organizations and individuals utilizing the technology as opposed to based on understanding of the available evidence regarding the technology.

**CHAPTER:8**

**APPLICATIONS**

Nuclear batteries find manifold applications due to its long life time and improved reliability. In the ensuing era, the replacing of conventional chemical batteries will be of enormous advantages. This innovative technology will surely bring break-through in the current technology which was muddled up in the power limitations.

**SPACE APPLICATIONS:**

In space applications, nuclear power units offer advantages over solar cells, fuel cells and ordinary batteries because of the following circumstances:

**1.**  When the satellite orbits pass through radiation belts such as the Van-

Allen belts around the Earth that could destroy the solar cells.

**2.** Operations on the moon or Mars where long periods of darkness require heavy batteries to supply power when solar cells would not have access to sun light.

**3.** Space missions in opaque atmospheres such as Venus, where solar cells would be useless because of lack of light.

**4.** At distances far from the Sun, for long duration missions where fuel cells, batteries and solar arrays would be too large and heavy.

**5.** Heating the electronics and storage batteries in the deep cold of space at minus 245 degrees Fahrenheit is a necessity.

So in the future it is ensured that these nuclear batteries will replace all the existing power supplies due to its incredible advantages over the other. The applications which require a high power, a high life time, a compact design over the density, an atmospheric conditions-independent ,it’s quite a sure shot that the future will be of ‘Nuclear Batteries’. NASA is on the hot pursuit of harnessing this technology in space applications.

**MEDICAL APPLICATIONS**:

The medical field finds lot applications with the nuclear battery due to their increased longevity and better reliability. It would be suited for medical devices like pacemakers, implanted defibrillators, or other implanted devices that would otherwise require surgery to replace or repair The best out of the box is the use in ‘cardiac pacemakers’. Batteries used in Implantable cardiac pacemakers-present unique challenges to their developers and manufacturers in terms of high levels of safety and reliability and it often pauses threat to the end-customer. In addition, the batteries must have longevity to avoid frequent replacements. Technological advances in leads/electrodes have reduced energy requirements by two orders of magnitude. Microelectronics advances sharply

reduce internal current drain concurrently decreasing size and increasing functionality, reliability, and longevity. It is reported that about 600,000 pacemakers are implanted each year worldwide and the total number of people with various types of implanted pacemaker has already crossed 3 million. A cardiac pacemaker uses half of its battery power for cardiac stimulation and the other half for housekeeping tasks such as monitoring and data logging. The first implanted cardiac pacemaker used nickel-cadmium rechargeable battery, later on zinc-mercury battery was developed and used which lasted for over 2 years. Lithium iodine battery, developed in1972 made the real impact to implantable cardiac pacemakers and is on the way. But it draws the serious

threat that this battery lasts only for about 10 years and this is a serious problem. The lifetime solution for the life is nuclear battery. Nuclear battery are the best reliable and it lasts a lifetime. The definitions for some of the important parts of a battery and its performance are parameters like voltage, duty cycle, temperature, shelf life, service life, safety and reliability, internal resistance, specific energy (watt-hours/kg), specific power (watts/kg), and in all that means nuclear batteries stands out. The technical advantages of nuclear battery are in terms of its longevity, adaptable shapes and sizes, corrosion resistance, minimum weight, excellent current drain that suits to cardiac pacemakers.

**MOBILE DEVICES**:

Xcell-N is a nuclear powered laptop battery that can provide between seven and eight thousand times the life of a normal laptop battery - that's more than five years worth of continuous power. Nuclear batteries are about forgetting things around the usual charging, battery replacing and such bottlenecks. Since Chemical batteries are just near the end of their life, we can't expect much more from them. In its lowest accounts, a nuclear battery can endure at least up to 5 years. The Xcell-N is in continuous working for the last 8 months and has not been turned off and has never been plugged into electrical power since new. Nuclear batteries are going to replace the conventional batteries and adapters, so the future will be of exciting innovative new approach to powering portable devices.

**AUTOMOBILES**:

Although it’s on the initial stages of development, it is highly promised that nuclear batteries will find a sure niche in the automobiles replacing the weary convent ionic fuels. There will be no case such as running short of fuel and running short of time.’ Fox Valley Electric Auto Association, USA’ already conducted many seminars on the scopes and they are on the way of implementing this. Although the risks associated with the usage of nuclear battery, even concerned with legal restrictions are of many, but its advantages over the usual gasoline fuels are overcoming all the obstacles.

**MILITARY APPLICATIONS:**

The Army is undertaking a transformation into a more responsive, deployable, and sustainable force, while maintaining high levels of lethality, survivability, and versatility.

In unveiling this strategy, the final resource that fit quite beneficial is ‘Nuclear Battery’.

‘TRACE Photonics, *U.S. Army Armaments Research, Development & Engineering centre’* has harnessed radioisotope power sources to provide veryhigh energy density battery power to the war fighter. Nuclear batteries aremuch lighter than chemical batteries and will last years, even decades. Nopower cords or transformers will be needed for the next generation ofmicroelectronics in which voltage-matched supplies are built into components.Safe, long-life, reliable, and stable temperature power is available from thedirect conversion of radioactive decay energy to electricity. This distributedenergy source is well-suited to active radio frequency equipment tags, sensors,and ultra wide- band communications chips used on the modern battlefield.

**UNDER WATER SEA PROBES AND SEA SENSORS**

The recent flare-up of Tsunami, earth-quakes and other underwater destructive phenomenon has increased the demand for sensors that keeps working for a long time and able to withstand any crude situations. Since these batteries are geared towards applications where power is needed in inaccessible places or under extreme conditions, the researchers envision its use as deep-sea probes and sea sensors, sub-surface, coal mines and polar sensor applications, with a focus on the oil industry and the next step is to adapt the technology for use in very tiny batteries that could power micro-electro-mechanical Systems (MEMS) devices, such as those used in optical switches or the free-floating "smart dust" sensors being developed by the military.

**CHAPTER:9**

**CONCLUSION**

The world of tomorrow that science fiction dreams of and technology manifests might be a very small one. It would reason that small devices would need small batteries to power them. The use of power as heat and electricity from radioisotope will continue to be indispensable. Microelectronics advances sharply reduce internal current drain concurrently decreasing size and increasing functionality, reliability, and longevity. As technology grows, the need for more power and more heat will undoubtedly grow along with it. Clearly the current research of nuclear batteries shows promise in future applications for sure. With implementation of this new technology credibility and feasibility of the device will be heightened. The principal concern of nuclear batteries comes from the fact that it involves the use of radioactive materials. This means throughout the process of making a nuclear battery to final disposal all Radiation Protection Standards must be met. The economic feasibility of nuclear batteries will be determined by its applications and advantages. With several features being added to this little wonder and other parallel laboratory works going on, nuclear cells are going to be next best thing ever discovered in the human history

CHAPTER: 10

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