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All Electric for the Millennium - Mobile Vehicle Recharge

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ABSTRACT

The development of a pollution-free transportation system for the millennium is provided by the recharging of a vehicle's non-polluting on-board energy storage unit (batteries, flywheel, whatever) as the vehicle travels unrestricted down the highway. This futuristic concept is called "VEHICLE REMOTE CHARGE - All Electric Vehicle Transportation via Wireless Power Transmission". The MOBILE VEHICLE RECHARGE utilizes microwave or laser technology for the mobile recharging of an energy storage unit on a non-hydrocarbon-fueled vehicle as well as sophisticated guidance systems to track and guide the energy beam to the vehicle. Thus the system uses military technology in a commercial application.

The transportation system incorporates technology from both the automotive and defense industries to combine the two in a commercial venture. This benefits the economy and assures economic growth into the new millennium while providing people the freedom of movement and mobility they currently have with the internal combustion engine vehicle. This recharge system can be used with electric or hybrid-electric vehicles.

This is for both public transportation vehicles and private automobiles. The system can start out small in downtown areas with public transportation, then expand into suburban and even rural areas.

To date, the most reliable electric source, especially for city travel, has been overhead tethered lines or on-ground tracks in public transportation. But these greatly reduce the convenience of route changes and are at the mercy of small traffic pattern changes which can cause traffic tie-ups. The ideal electric bus would have a completely mobile energy source, such as a battery pack. But the limited range of a battery powered vehicle has restricted its use to only specific cases. In private vehicles also, the limited range of zero-pollution battery power has reduced the desirability of all-electric transportation.

The charging of these on-board electrical energy storage systems will take place via a wireless power transmission network that will be established along the roadside on existing power line (telephone) poles or new stand-alone poles that would be in conjunction with the existing poles. The idea of transmitting electric power using a conductorless method has been in existence since the turn of the century. Microwave and laser based systems provide wireless energy transmission.

There will be issues about the environment, safety, and government regulations that must be addressed. But technological advances with a discerning government can make this system a reality. These concerns will be discussed in the paper.

INTRODUCTION

The proposed transportation system will provide all Americans (and the world) the same freedom of movement that we currently enjoy with the IC engine powered automobile. The all-electric vehicle transportation system has the same power, maneuverability and range capability provided by today's vehicles.

The Vehicle Remote Charge network will recharge the energy storage unit in the electric vehicles utilizing wireless power transmission. The electrical energy storage system can be batteries, an electric motor driving a mechanical flywheel, an ultra-capacitor, or some other means to store the energy for use in driving the vehicle. The method of storing the energy on the electric vehicle is not unique. How the energy storage unit is recharged, and that the system is all-electric transportation, <u>are</u> unique.

The electric vehicle can be either for public transportation and, as the system expands and becomes more prevalent around the country, extended to include private automobiles. The system is capable of growing nationwide as did the Rural Electrification Program back in the 1930s and 1940s.

The idea of transmitting electric power by conductorless means has been around for many years. Now the technology will be used to establish a nationwide transportation system using solely electrical energy.

The original wireless power transmission system was proposed to augment the existing system of electrical conductors that are used to move large quantities of electrical power over long distances. In the mid-1960s a system was proposed to convert large quantities of solar energy into an energy beam that could be transmitted from outer space to the surface of the earth through satellite transmissions. Once on earth, the energy beam would be converted back to a usable voltage form that would be pumped into the existing electrical grid.

To minimize the energy loss from the beam as it travels through the atmosphere, several transmission frequencies of the energy spectrum have been considered. For an RF energy beam, atmospheric attenuation is a minimum up to 4 GHz, even during a heavy rainstorm. Other windows of transmission exist at 35 GHz and 94 GHz. Systems designed to operate at these higher frequencies have the added advantage of operating with smaller transmitting and receiving antennae. But these systems have been considered for transmission distances of kilometers in conjunction with satellites in low earth orbit or geosynchronous orbit, transmitting to the surface of the earth. Transmitting from space to the surface of the earth also eliminates laser beams from traveling long distances in the earth's atmosphere.

For the Vehicle Remote Charge system, distances of 200 to 500 meters are all that would be needed. Therefore many more RF bands become available, as well as laser beam viability. The laser energy beam has the added advantage of having very small transmitting and receiving antennae; although laser receivers can take on many forms.

The Vehicle Remote Charge system, utilizing the wireless power transmission technology, would first be established at passenger loading/unloading locations in downtown areas to replace high polluting public transportation systems where the vehicles travel on predetermined, scheduled routes. The completely mobile vehicle will receive remote charging for intervals of a few seconds up to several minutes as it comes within range of each charging station located along its route. The receiver will be mounted on the top of each vehicle with transmitters and aiming devices strategically mounted on poles along the route. The mobile vehicle charging network is a futuristic means of transportation that will replace the internal combustion (IC) engine with a clean, non-polluting, renewable energy source providing mobility for the nation in the new millennium. Sure, a few glitches need to be ironed out, but this will be the mode of transportation for future generations.

SYSTEM OPERATION

The motive drive of the vehicle can be all-electric or hybrid electric. The power usage monitoring device is the main logic device for controlling power management inside and outside the vehicle. This would be a digital processing unit that would have to monitor the amount of energy available to the vehicle at all times from both the on-board energy storage unit and/or the Vehicle Remote Charging System [1].

A demand for charging can be triggered by the vehicle energy storage unit, for example a battery pack, calling for recharge, or any other predetermined parameter noting a drop in the stored energy of the battery pack. This call for charging activates the Vehicle Remote Charging System. The vehicle sends out a radio signal calling for charging. The signal is transmitted by a small transmitting antenna mounted on the vehicle. This translocator (transmitter + location) signal, similar to a transponder signal, identifies the vehicle as needing a charge to the Vehicle Remote Charging System. The signal then becomes a guide beacon to locate the vehicle so that roadside recharging units know the vehicle's location at all times.

The roadside recharging devices, called Power Transmitting Units, are stationary units that would be mounted on stand-alone poles or existing telephone or light poles. These units would be connected to the existing electric power grid to be utilized as the source of electrical energy and would be metered appropriately. Located in the Power Transmitting Unit would be the circuitry needed to send the wireless power transmission beam. This includes the tracking signal unit that would detect and track the vehicle's guide beacon. That is, the Power Transmitting Unit locks onto and tracks the vehicle's translocator signal. The Power Transmitting Unit also contains the aiming device for directing the power beam at the vehicle for recharging the battery pack as it travels along. Therefore, the translocator signal alerts the Power Transmitting Units that a vehicle is present and calling to receive a power beam for recharge. Figure 1 shows the essential components of the system.

When in the range of a Power Transmitting Unit, the translocator signal is picked up by the power transmitter's receiver and identified as a qualified end user. This signal can be encoded or encrypted to eliminate wrongful responses. The alerted Power Transmitting Unit then sends out a signal to alert the translocator that it is aware of its presence - the two units in effect shake hands to acknowledge the local existence of each other. Therefore, an electronic linkup is made between the two units; the tracking unit in the Power Transmitting Unit then locks onto the movement of the vehicle with the translocator signal as the guide beacon so the energy transfer can begin.

With the electronic linkup, the tracking unit in the Power Transmitting Unit becomes the aiming device. The tracking unit uses the translocator signal to aim the power beam at the vehicle and hit the proper location on the antenna so there is no wayward, wasted or lost energy during the transmission of power, both for safety and for more efficient power transmission.

The power unit then commences to charge the energy storage unit of the vehicle, using the wireless power beam, no matter where the vehicle travels in the range and sight of the Power Transmitting Unit. Recall, this communication and charging takes place at 186,000 miles per second, the speed of light. Therefore the vehicle will only travel a distance of micrometers while the acknowledgement and linkup take place.

The electric vehicle, also shown in Figure 1, would have the power receiving antenna located on the vehicle in a convenient location. The receiving antenna can swivel toward the power source for better energy absorption. Also shown is the translocator antenna/receiver for the guide beacon. The electric vehicle would also have a compendium of components that would aid in the operation and care of the all-electric vehicle.

There would be an energy storage device; as discussed above, a battery pack or any other energy storage device. Shown in Figure 1 is the motor control unit. This would be the main controller in the vehicle that would coordinate the flow of energy from the energy storage unit to the electric drive motor. It would also oversee the energy produced during regenerative braking and stored for later use. The motor control unit would monitor the amount of energy that is consumed in the vehicle as well as the energy that is beamed to the vehicle during recharging.

Operator control would be standard control by the driver to operate the vehicle. To ease the transition between today's IC engine driven vehicles and this all-electric system, the vehicle in Figure 1 can be hybrid electric. Therefore when a Power Transmitting Unit is not encountered in a timely manner, a hydrocarbon or fuel cell fueled engine can recharge the vehicle. As the Vehicle Remote Charge network becomes more prevalent, hybrid vehicles will be obsolete.

Figure 2 shows the public transportation system in full operation at a busy city street corner. Three city buses are in the process of going through the intersection. One bus is loading/unloading passengers. A second bus has finished loading/unloading passengers and is pulling away from the curb and around the first bus that is still busy at the corner with passengers. A third bus is traveling through the intersection without a passenger stop at this location. Note that all three buses are having their energy storage systems recharged while they are in the intersection.

Any one of the three buses could change position with any of the other buses and there would be no difference as far as energy beams are concerned. The first bus that arrives in range of the Power Transmitting Unit has its translocator signal locked onto by one of the power energy beam transmitters. The second bus that arrives in range of the Power Transmitting Unit has its translocator signal locked onto by the next available power beam, and so on. The Power Transmitting Unit can be built to have several power beams transmitted from it. A priority system can be set up so that the beams are activated in a particular order, and the order can be rotated so that all transmitting units obtain the same amount of usage time.

The coded communication enables multiple vehicles to be charged at a single pole location without energy beam cross-talk or confusion. The system may become so sophisticated that transmitters could trade translocator beams and hence power beams to eliminate the destructive interference that may occur between power beams if they cross for too long a time. In addition, coded translocator guide beacons could allow user identification to electric power companies for billing purposes.

Once the translocator signal is lost by the Power Transmitting Unit or the translocator loses the power beam from the Power Transmitting Unit, all communication between the charge unit and the vehicle are considered lost, and charging is stopped. A relink would have to be established before commencement of recharging could start. If the energy storage device is completely charged, the translocator signal is shut down, and there is no transfer of energy.

Figure 3 shows the system including private vehicles. Figure 1 showed the components of an electric vehicle for public transportation. This can easily be accommodated to include the same components for private vehicles. And the Power Transmitting Unit network can be expanded to rural areas by utilizing existing telephone poles. If the predominantly wooden poles are not secure enough for the Power Transmitting Units, then only poles that have a unit mounted on top could be replaced with a fiber glass or steel pole. Electric vehicle bus routes can be extended to rural areas first, then private vehicles implementing the energy beam receiver and translocator concept could be integrated into the system.

Figure 4 illustrates two of the possible methods for charging the energy storage unit in a private vehicle when not in use. Parking areas on city streets would have coin operated charging meters so the vehicle can be charged while the owner is doing errands, or the meter may be in front of the residence of the vehicle owner. Also, a private electric vehicle may be garaged at home where a charging unit has been installed above the vehicle as shown.

An electric vehicle is part of the charging network when properly eqiupped to transmit the translocator signal and receive the power beam. Also, the vehicle operator will purchase energy from the power grid. This is accomplished using an energy card or counter that keeps track of the purchased energy. This energy counter is no different from a print counter used at a public copy store or a long distance phone card purchased at a convenience store, something Americans are used to dealing with daily. The counter or card would be plugged into the vehicle's dashboard where the operator would have a visual readout of the energy available on the card. This is similar to the current readout that shows the amount of fuel that is left in the "gas tank". When the available energy is low, the operator must buy more "fuel", i.e., more energy units.

If the counter or card had zero energy units, that is, the "fuel tank" is empty, the translocator signal could not be activated. Therefore no energy is available to the vehicle from the Vehicle Remote Charge network. More fuel must be purchased.

For a hybrid-electric vehicle, when not in the range of a Power Transmitting Unit (for example in extreme rural areas), the backup hydrocarbon-fueled (or future fuel cell-fueled) engine would cycle in to recharge the energy storage unit to eliminate the out-of-fuel condition. Once in contact with a Power Transmitting Unit, the backup engine can be shut down.

To better explain the operation of the Vehicle Remote Charge system, some examples will be presented. These examples will also provide orders of magnitude required for system parameters in the operation of the system and will illustrate that the technology, with some refinements, is in existence today.

The first example will be a battery powered city bus. Consider a 46-passenger public transportation vehicle, having a mass of 15,000 kg and a 195 kw (277 hp) electric motor. For city travel, consider Power Transmitting Units to be every 1 km. For a busy downtown street, there may actually be one every 200 to 300 meters, but we will use 1 km distance for the example. Consider the bus to be traveling at 55 km/h (35 mph) and a Power Transmitting Unit to have visibility of the bus 150 m prior to the unit and 150 m after the unit. Therefore, the Power Transmitting Unit has visibility of the bus for 300 m and can charge the on-board energy storage unit for 19.64 seconds.

The amount of energy that can be transferred via wireless power transmission has been upwards of 450 kw. The efficiency of such energy transmissions has been estimated to be about 76%. Therefore, for the example, a conservative value of 150 kw will be received and stored in the energy storage unit of the bus. At 55 km/h, the energy storage unit will receive 0.8182 kw-h of recharge energy as it passes the Power Transmitting Unit. Although the bus has a full power capability of 195 kw, when the vehicle is traveling at 55 km/h, it utilizes about 35 kw (allow 5% for utilities: lights, wipers, etc.). With the Power Transmitting Units every 1 km, the bus will consume 0.6364 kw-h of energy. That is 22.2% less than can be supplied by the Power Transmitting Unit. Therefore the bus would not have to receive electrical power from the Power Transmitting Unit the entire time between units if the battery pack on the bus were fully charged at this junction of time. This example shows that the system has excess capacity and that the parameters can be adjusted for other conditions.

The next example will be with an urban vehicle or private passenger car. For the urban setting, we will now consider Power Transmitting Units to be located every 2 km. The urban vehicle will be about 750 kg with a 28 kw (40 hp) electric motor. Traveling at 105 km/h (65 mph) the vehicle will require about 17.5 kw of electric power (allow 5% for utilities: lights, wipers, etc.). Again, with the Power Transmitting Unit's line of sight of the vehicle being 300 m, the energy storage unit will receive 0.4286 kw-h of recharge energy. The vehicle will consume 0.3328 kw-h of energy traveling at 105 km/h with 2 km between the Power Transmitting Units. This is 22.4% less energy used than is available from the Power Transmitting Unit. Therefore again there is enough flexibility in the system to allow more than one vehicle to be charged by one Power Transmitting Unit, or the power requirements can be reduced, or other system parameters can be adjusted.

In summary, the energy beam guidance signal is sent out by the vehicle's translocator to alert local Power Transmitting Units that a vehicle is present requiring a charge. The Power Transmitting Unit's tracking device detects the presence of the translocator guide beacon and establishes a proper electronic linkup between the vehicle and the power unit. The power unit's tracking and aiming devices follow the progress of the vehicle. The power unit then transmits the wireless power beam to the antenna while following the path of the vehicle, where the energy beam is conditioned by the energy beam receiver into a usable power form. Charging of the energy storage unit continues until the translocator signal is lost or interrupted.

SAFETY

Concerns that may arise in using wireless power transmission to charge an electric vehicle are the effect of the energy beam on humans or other forms of life, the effect on inanimate objects, and the impact on the environment. After years of investigation and observation, the only effect of the RF energy or a laser beam on living tissue is the heating effect. On vehicle components other than the receiving antenna or other structures around the vehicle, the energy beam as described in this system will bounce off harmlessly and quickly be dissipated. If the system went completely awry and struck a person, that person would not even know that he had been struck by the beam. As the system is designed to do, the only possible side effect would be an imperceptible warming on the person's skin where the beam had struck him.

The effect on the environment would be added thermal energy. However, the level of added heat compared with what is added to the environment currently by an internal combustion engine vehicle is miniscule. In absolute terms, it is estimated that an energy beam would add less than 20 W/sq.m. This level is very small compared to the energy that is absorbed from natural processes such as solar radiation. Therefore the overall effect on the environment is minimal and represents a considerable improvement over what it is replacing, both in thermal pollution and zero emissions.

The safety of the power transmission system is an all-important subject that must be considered if this transportation means is to be a serious contender for future use in this country. The major safety issue concerning the use of wireless power beams around humans is being directly struck by a wayward beam. Several areas of safety are being developed by PARISE RESEARCH TECHNOLOGIES to guarantee that: (i) any human or animal struck by the energy beam will experience no more of an effect than an imperceptible warming of the skin: (ii) any malfunction of the receiving or transmitting process will result in the immediate shutdown of the power delivery system; and (iii) the power delivery unit will not operate except when encountered by a proper end user, i.e., a vehicle to be recharged.

This may sound idealistic considering that all human designs have flaws that can cause failures, and hence human injury. But if the system safeguards are designed so that the failures cause the system to shut down before human injury can occur, then the integrity and operation of the system are enhanced. There are also possible design features of particular system components, for example the power beam receiver, that can reduce the risk of wayward and possibly dangerous energy beams. Unfortunately, these particular designs and safeguards cannot be discussed at this juncture in time. Development is an ongoing project that will be revealed at a future date.

But consider many of the inherent safety features that are a natural part of the operation of this system based on overall performance.

The translocator signal will be encoded or encrypted for only proper Power Transmitting Unit usage when the receiver identifies and qualifies the signal as an authorized user to eliminate wrongful responses. The alerted Power Transmitting Unit then acknowledges the presence of the vehicle with the appropriate electronic handshake and linkup between the two units. The tracking unit in the Power Transmitting Unit then locks onto the movement of the vehicle with the translocator signal as the beacon for safe, secure energy transfer.

The energy beam guidance signal does just that, it guides the energy beam to the proper location on the vehicle. This is for proper location on the vehicle receiver to absorb the energy at the highest efficiency possible and for the safety of vehicle occupants and pedestrians, eliminating wrongful exposure. This is for the safe and efficient transfer of energy to the vehicle.

When the energy storage unit is full (completely energized), the translocator shuts down, the power transmitting unit is shut down, and there is no more transfer of energy. Another safety feature of the system. No excess energy transfer or wayward energy beams.

The signal of the translocator is "locked onto" by the power transmitting unit, another obvious safety feature that the system utilizes. This is a very important aspect of the many safety features that are inherent in the system design.

The translocator is positioned in the center of the receiving antenna. The tracking of the translocator signal by the Power Transmitting Unit aims the energy beam at the translocator beacon. Therefore the energy beam echos back directly to the center of the receiving antenna. The antenna will absorb a large portion of the energy that is beamed at it. The remaining energy will be reflected off the lower surface of the antenna or absorbed by a special material, dissipating harmlessly.

As described above, if the translocator beam is not seen by the power energy beam, the Power Transmitting Unit will shut down and not respond any longer. Therefore no dangerous wayward energy will be transmitted.

A concern of the operation of the system would be that vehicle occupants are exposed to the energy. Of course, part of the obvious solution (along with many of those already mentioned) would be some type of insulation between the passengers and the energy beam receiving area. This would be similar to the protection provided by the fire wall in current automobiles. This is the partition between the engine and the passenger compartment. Therefore some type of protection may be wanted between the passengers in the vehicle and the energy power beam receiving antenna as an added safety feature to eliminate any long-term exposure that may (although highly unlikely) result.

Although specific designs for power beam energy receivers have not been considered, certain configurations would have inherent safety features. This would eliminate the concern for wayward or lost energy both for safety concerns and the increase in overall efficiency. These are currently in the development stage and will not be discussed at this time.

The possible theft or wrongful use of the power beam is certainly a possibility that could lead to dangerous situations. However the coded and encrypted response signals would eliminate this form of energy piracy or tampering.

Obviously, many circumstances can be contrived to render the safe use of the Power Transmitting Unit questionable. But more interlocking safety devices can be added to the circuitry to prevent the system from operating except only under those conditions that are deemed safe for the system and for the public. It is not unusual to have many interlocking safety checks before operating a possibly dangerous and complex system. When all the safety checks have been satisfied, the equipment is ready to use. And the safety attributes are constantly monitored during equipment operation. Other problems may also be envisioned for the safe operation of the Vehicle Remote Charging System, but none that cannot be dealt with for safe operation of the system.

Another safety feature that is inherent in the design of the system is that the power energy beams do not travel long distances (200 to 500 m, at most, for example). Therefore problems that would be associated with long distance transmission of a wireless energy beam are not encountered. When long distances are involved, the beams spread out considerably, and any objects that may cross the beam path will be in the energy beam for seconds or minutes. This long exposure time can present a serious health hazard for humans. However, this system does not have the problem of long distance transmission.

The line-of-sight power transmission and immediate shutdown upon interruption of the signal also tremendously simplify the installation of the system and are a great safety feature. Instead of having to move many physical objects that may transiently obstruct the transfer of energy, let the electronics of the system take care of it. For example wires, small branches, protrusions of buildings, pigeons, etc., will block the signal momentarily. The power beam will cease, but the translocator will continue to call for energy, if necessary. Therefore the power beam can reestablish contact with the vehicle on the other side of the obstruction and continue to recharge.

For assured safety, almost any electrical failure on the vehicle can be designed to have an appropriate shutdown of the translocator signal so that the vehicle could not alert a Power Transmitting Unit to start tracking and charging the vehicle. The vehicle operator would always have to be notified of this, or any failure, so that the vehicle can be serviced. Otherwise, a no-fuel condition will prevail, causing an inconvenience for the operator.

An electrical failure in the Power Transmitting Unit would also cause an appropriate shutdown of the power beam to ensure the system integrity. This is not unusual for any power equipment that operates around humans and is a very safe and successfully proven mode of operation. This would include standard fusing in power surges, lightning protection, protection from moisture damage, varment infiltration, etc.

With the many safety items that are spelled out above, there is one more safety feature that can be added to the Vehicle Remote Charge System that is not easily added to the internal combustion engine. That is system redundancy. Electronic safety systems use microelectronics to monitor system attributes. Microelectronic systems are extremely reliable as evidenced by the space program that has been carried out by the U.S., Russians, Europeans, etc., for many years. This reliability cannot be overlooked when considering the overall safety of the Vehicle Remote Charge System -- space age technology (and safety) is being used in the public sector, very little of which is used in the automotive industry today.

Also, microelectronics is a well-established technology that can add redundant systems at a small cost. Therefore redundancy is a very effective, viable and reliable method to increase the safety of the system. Since the electronic devices are normally very small, additional equipment can be added, relatively unnoticed, to the system, through miniaturization. The addition of redundancies is a simple process, not something that becomes cumbersome or unwieldy. These redundancies add an immeasurable degree of security and safety that will render the system useful and reliable in the public sector.

Although the safety features have been specifically referred to for a microwave and/or laser based wireless energy transmission system, these do not preclude the use of any other type of wireless energy beam that may be developed in the near future. Electron beams, ion beams and other technologies that may show promise or have technological breakthroughs are also feasible in a wireless power transmission network and would have the same inherent safety features and added devices as utilized in the Vehicle Remote Charge System described above.

Consider many of the inherent safety features that are a natural part of the operation of this system compared with the dangers that exist with our current means of transportation. Also, the standard safety features that are built into any piece of power equipment will be utilized in this system as well. The workings and operation of the Vehicle Remote Charge system, when contrasted with the current means of transportation, are a much safer operating transportation system. Vehicles now have large amounts of liquid fuel present that are combustible and explosive, and therefore very dangerous. The 20 or more gallons of gasoline that people must carry in their vehicles as they travel around town are extremely volatile. There are many fiery explosions that take place in vehicle collisions on the roadways, putting vehicle occupants, bystanders and safety personnel at great risk. These fiery explosions would be virtually eliminated with this system, and the safety features discussed herein will ensure the safe operation of the system under all adverse conditions.

No vehicles will travel around with gallons of volatile fuels that do explode and burn in automobile accidents. No vehicles will be spewing out tons of pollutants into the atmosphere damaging lungs. No unhealthy toxins will be lowering the health standards of many

Americans. None of these dangers or problems exist with the Vehicle Remote Charge network.

REGULATIONS

There are regulations in place today that limit the amount of electromagnetic energy that can be transmitted through the atmosphere. There is no doubt that these must be revised and updated to accommodate the use of wireless power transmission in vehicle operation. Cooperation at both the state and federal government levels must be attained for the implementation of the system. The federal government must commit to an environmental cleanup to eliminate both thermal pollution and emission pollutants that are a burden on our environment.

There is a certain degree of education required to assure the public that there is no harm around the use of these levels of energy except for the thermal exposure discussed above. Laser surgery is performed inside the human body and there are no adverse effects. Mankind is surrounded by RF waves constantly with no known effects. The power beam that is transmitted directly to a power receiver will be absorbed virtually 100%. Therefore those people living and working around this means of energy transfer should be comforted to know that they will have no interaction with the energy beam.

CONCLUSIONS

The Vehicle Remote Charge system provides a viable means of all-eletric transportation for the new millennium. All of the technology is available today with the engineering know-how to implement the system. The infrastructure is in place to position the Power Transmitting Units along the roadside, and the once common corner service station has become a mart to sell conveniences with gasoline pumps out front. Why not eliminate these dangerous fuel pumps out front and add fuel cards or counters to the mix of phone cards that stores already handle? Then we will have moved into the 21st Century with clean, safe, reliable, independent transportation.

SUMMARY

Recall the many advantages and improvements that the Vehicle Remote Charge System provides over current or recently proposed transportation. Although the advantages of this all-electric transportation network are too numerous to list, and obvious from the description provided, highlights of the system are:

1. Replace internal combustion engine with all-electric vehicle utilizing renewable energy source and eliminating pollution emissions problem;

2. The electric vehicles have full mobility, especially on crowded downtown streets for public transportation systems, and are not confined to special lanes where the roadway has been prepared to accept and recharge these special vehicles;

3. The system can start out small in downtown areas and expand slowly to include the outskirts of the downtown area and then grow into suburban areas;

4. The network can be installed with minimum impact on downtown streets because the bulk of the work will take place above the sidewalks, so there will be no torn up city streets needed to accommodate the new system;

5. The network is expandable to start out replacing public transportation vehicles first, then as the system grows, private all-electric vehicles can be added to the system;

6. The system can show an immediate payback for the funds necessary to start up the system -- initial revenues from public transportation will pay for expansion into the private sector, where revenues will increase significantly;

7. The Power Transmitting Unit and the translocator guide beacon lock signals to communicate with coded and/or encrypted transmissions for system safety;

8. Studies have shown the only effect to humans by microwave or laser beam is heating;

9. Communication signals and power beam are locked in a secure electronic linkup for safe use of the system;

10. System development will ensure limited human exposure to the high power energy beam;

11. The danger and the fiery explosions that occur with the present 20 or more gallons of gasoline in the vehicle are eliminated;

12. Line-of-sight operation only is a tremendous attribute for the safe performance of the system;

13. Safety component redundancy is simple and viable with electronic systems;

14. The translocator guide beam originates in the center of the receiving antenna to ensure proper placement of the power beam on the vehicle receiver.

CONTACT

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ALL-ELECTRIC VEHICLE CONCEPT with WIRELESS ENERGY RECHARGE

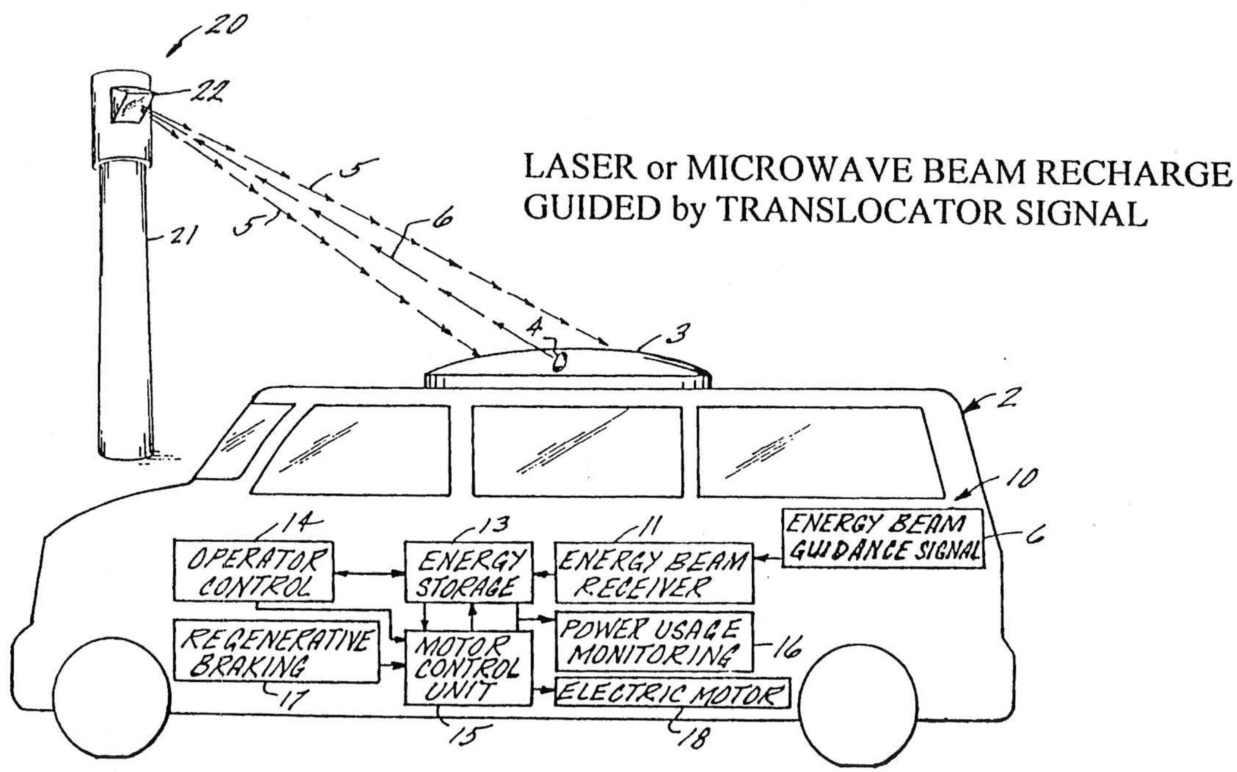
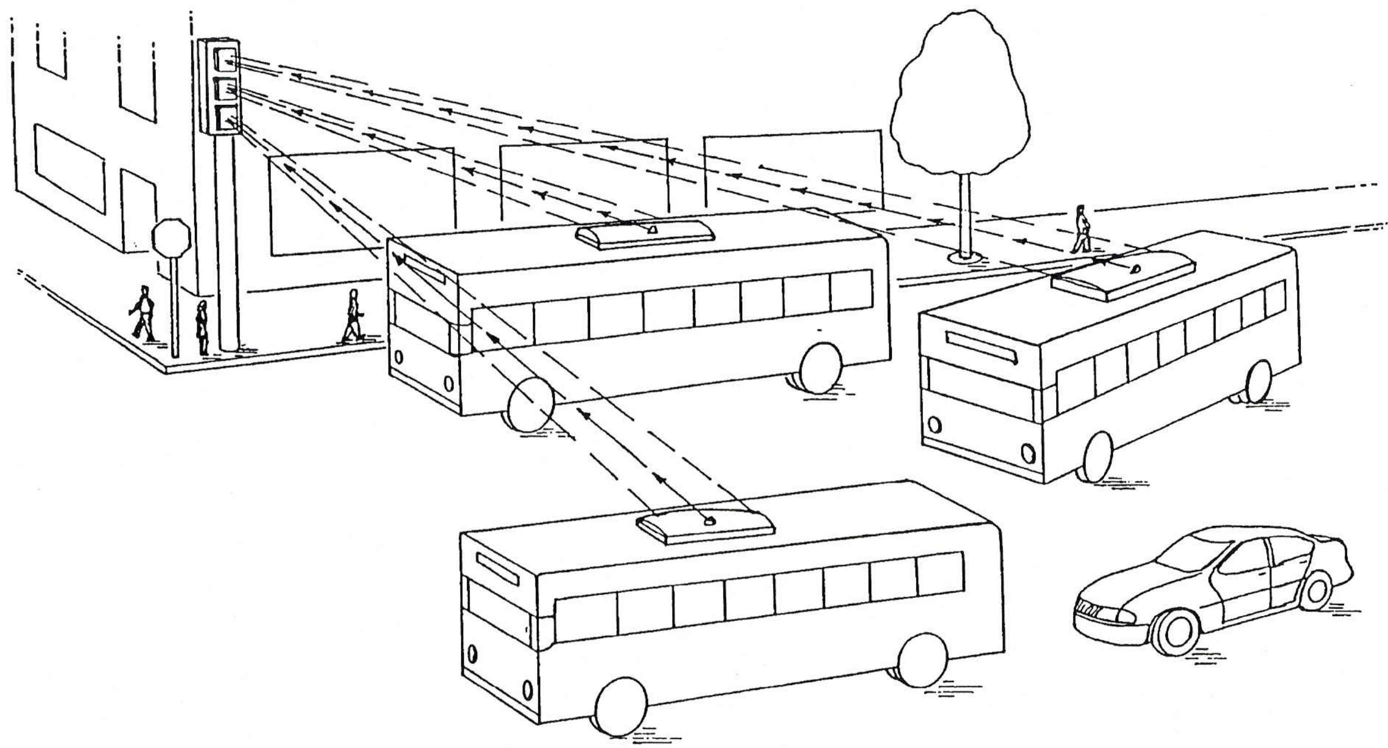


FIGURE 1.



LASER or MICROWAVE WIRELESS
ENERGY RECHARGE in TRAFFIC

FIGURE 2.

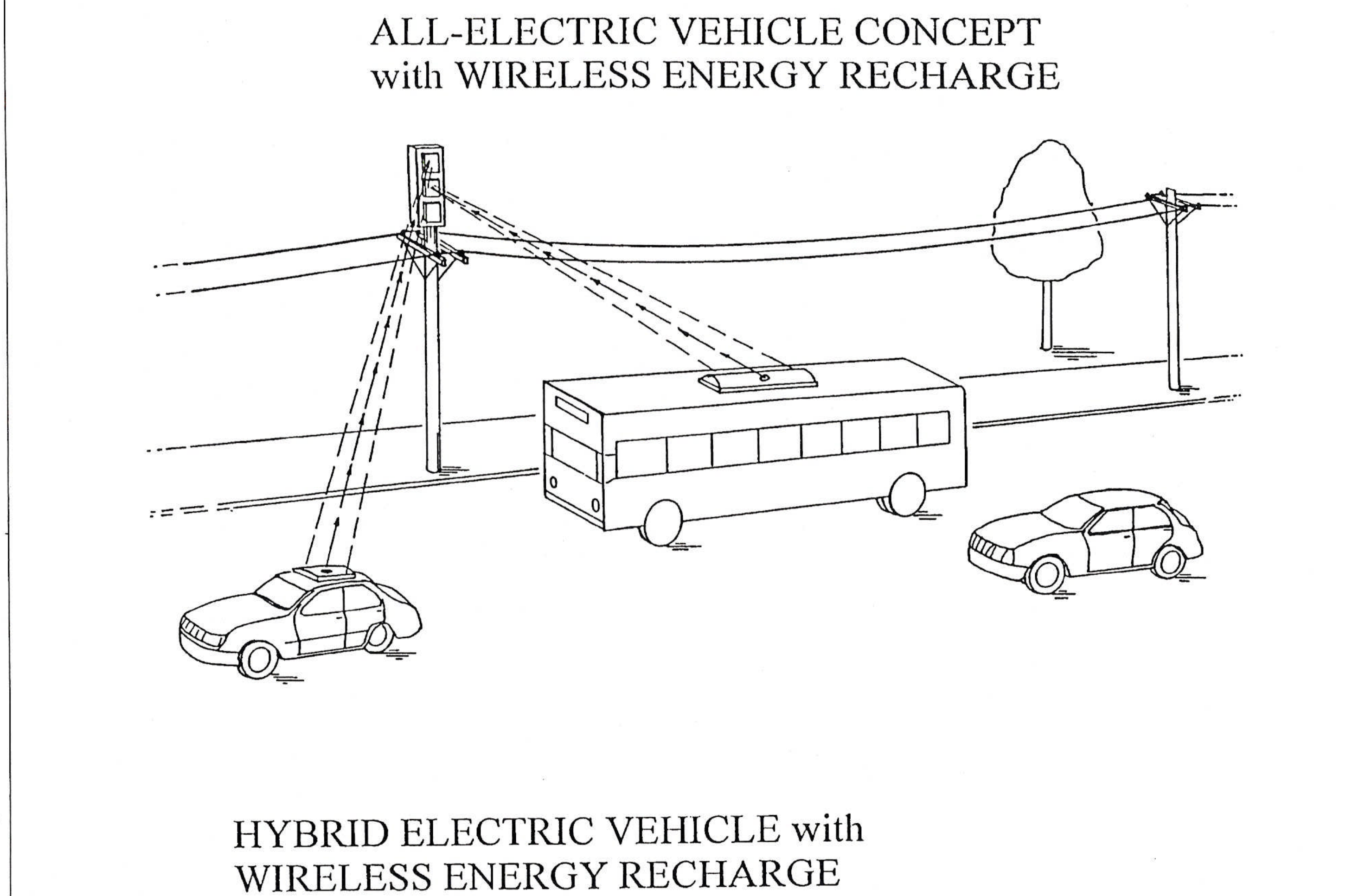

ALL-ELECTRIC VEHICLE CONCEPT
with WIRELESS ENERGY RECHARGE
HYBRID ELECTRIC VEHICLE with
WIRELESS ENERGY RECHARGE

FIGURE 3.

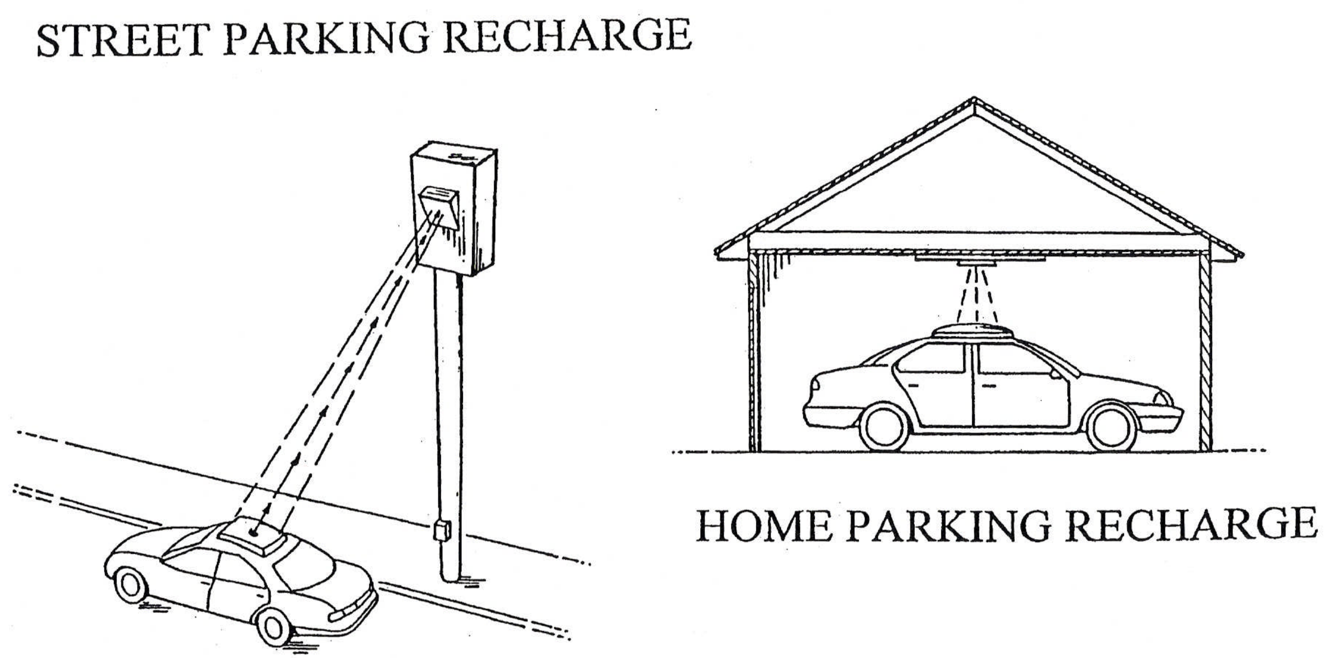


FIGURE 4.