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Automotive Power Drive System

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ABSTRACT

By designing a system with configuration of various mechanical, electrical equipment a unique way of generating sufficient electricity economically to run electric vehicles can be employed. A Battery Pack of suitable capacity is built in the vehicle's available area. Initially the same is assembled to have a pre-determined voltage and amperage. Initiating the process of electricity generation by letting the electric current to flow through the system is as explained in the following pages. In this design, various unique features of equipment are exploited to generate electricity on board to run the vehicle.

To start with, a D.C. Motor will be operated using the D.C. Power from the Batteries Pack. Next, the D.C. Motor will drive set of two pulleys. This arrangement will decrease the output speed, but increase the torque proportionately. The output of second pulley will drive the Fluid Coupling, which acts as the torque converter. The output of the Fluid Coupling is connected to the D.C. Generator, which in turn is connected to the clutch, gear box, axle differential gear box and rear wheels of the vehicle. Part of power generated by the D.C. Generator is fed back to the Battery Pack through the D.C. Controller. In this unique design feature, the designed system will continue to produce D.C. power as long as the Batteries Pack and D.C. Motor and D.C. Generator last. In this way more power than that produced by Batteries Pack, can continue to be produced till the lives of D.C. Motor, D.C. Generator and Batteries Pack life are over. Please refer to the Conclusion.

1. INTRODUCTION:

The crisis created by the ever increasing fuel prices is well-known to the vehicle users at large. Whenever there is price hike in the fuel prices much inconvenience is caused to the general public. The undersigned Author and Originator of the said Research Paper has found a solution to this ubiquitous fuel crisis. The same can be resolved by practically implementing the scheme envisaged by him as described in the following pages:

2.1 The Equipment / Machinery List with relevant information is as enumerated below: (Refer TABLE "A")

As can be seen from the schematic diagram, some modifications are envisaged in the conventional vehicle. These come in the form of additional features as enumerated below:

1) D.C. Batteries Pack (1 No. Pack). A Batteries pack of Lithium Ion Batteries of suitable number as per the design would be used. This will depend upon the size / capacity (HP/KW) of the D.C. Drive Motor. Lead Acid Batteries Pack option can be considered for economic reasons.

2) D.C. Controller (1 No.). D.C. Controller would be of designed capacity suitable for controlling D.C. produced by the D.C. Batteries Pack, which would be fed to the D.C. Drive Motor and also to control the speed of the D.C. Motor.

3) D.C. Drive Motor (1No.). The D.C. Motor with a timer incorporated in the circuit would be driven by the D.C. produced by the D.C. Batteries Pack. The HP / KW of the Electric Motor would be determined as per the load capacity and an array of D.C Batteries.

4) Pulley No.1 (1 No.): This is mounted on the output shaft of the D.C. Motor. This will be designed to transmit torques at various speeds, as per design, to the Pulley No.2.

5) Belt (1 No.): Belt will be wound on the two Pulleys No.1 and No.2.

6) Pulley No.2 (1No.). This is connected to Pulley No.1 through suitably designed belt and a Fluid Coupling.

7) Plummer Blocks (with Bearings) (2 Nos.). Pulley No.2 and Belt System are mounted on a shaft supported between Bearings of Blocks which are bolted to the base plate.

8) Shaft (1 No.): One central shaft for Plummer Blocks and Pulleys will be provided.

9) Fluid Couplings (2Nos.). This is fitted between the Pulley No.2 and the A.C. Generator alongwith a Flywheel. This acts as **torque converter** to produce torque 2.5 times the input torque for 30 seconds and functions as per the timer incorporated in the electrical circuit of the D.C. Motor.

10) Flywheels (2 Nos.): Flywheels will be mounted on the fluid couplings' shafts suitably.

11) D.C. Generators (2Nos.). HP / KW of this equipment would be as per the output power of the D.C. Motor made available, through assortment of equipment as mentioned above, at D.C. Generator's input shaft. (**N.B.:** The D.C. Generator with double extension shaft will be used).

12) Output Shafts: Output shafts from the D.C. / A.C. Generators will be used to drive the car wheels.

13) On – Board Smart Battery Charger (1 No.). This gadget will take care of re - charging of the Batteries Pack that will be placed between the D.C. Controller and Batteries Pack.

14) D.C. to D.C. Convertor (1No.). This gadget transmits D.C. power. Its KW capacity would be as per the power that would be required to transmit from D.C. Generator to D.C. Batteries Pack.

15) D.C. to A.C. Inverter (1 No.): D.C. to A.C. Inverter of suitable capacity and reputed brand will be provided in the second option where A.C. Induction Motor will be used.

16) Junction Box No. 1 (1 No.): This Box of proper design and capacity will be provided for the Cables coming from the Batteries Pack and carrying current to the On – Board Smart Battery Charger.

17) Junction Box No. 2 (1 No.): This Box of proper design and capacity will be provided for the Cables coming from the On – Board Smart Battery Charger carrying current to the D.C. to D.C. Converter.

18) Electrical Cables (1 Lot): One lot of Electrical Cables of reputed brand, specifications and load carrying capacity will be provided in the circuit.

19) Chassis / Base Frame for Machinery (1 No.) and relevant Hardware (1 Lot). A chassis or base frame to fix all the machineries / equipment will be as per vehicle manufacturer's standard design.

2.2 Principle of Operation (Methodology): This Automotive Power Drive System would be employed in the areas where fuel is available at high costs or for that matter anywhere.

There are 2 options available at disposal to implement the above – mentioned system:

Option No.1: Here, as in any prevalent electric vehicle, a D.C. Motor as prime mover is used. The options available for an electric motor are: (i) B.L.D.C. Motor, (ii) D.C. Traction Motor. There would be a Batteries Pack (Array) consisting of a number of Lithium Ion Batteries of a suitable number connected in series which would give a voltage of 650 volts D.C. at 300 Amperes current which is enough for starting and running the designed electric car. This Batteries Pack would be installed at central area of the vehicle, where the following equipment (machineries) as well would be fitted. With the Batteries Pack, there would be an assortment of: (i) D.C. Motor, (ii) D.C. Controller, (iii) Battery Charger, (iv) D.C. to D.C. Convertor etc. The D.C. Motor would be fitted to the chassis. At the output shaft of the motor a set of pulleys and belt system plus 2 Torque Converters would be connected. (See the Schematic and Block Diagram).This would help to have high torque during start-up phase and facilitate smooth, shock free start and acceleration of the vehicle.

The Wheels rotate through the conventional drive system of transmission for an electric vehicle. A Self - Recharging Power Drive Unit (That is, On – Board Smart Battery Charging System) is installed at a convenient location in the

vehicle. As D.C. Generators' rotors rotate, they produce D.C., a part of which would be fed to the D.C. Batteries Pack after the same is transmitted through D.C. to D.C. Convertor and D.C. Controller, etc. The current carrying Cable would run through some convenient route of the vehicle. Thus, the D.C. Batteries Pack would get continuously charged through the On-Board Smart Battery Charging System, and continuously drive the BLDC Motor or the D.C. Traction Motor as the case may be. Thus, due to self-recharging principle the vehicle would continue to run as long as the system consisting of Batteries Pack and other machineries such as D.C. Motor and D.C. Generators last. The regenerative principle would also be used to produce electricity from the wheels themselves while the vehicle is decelerating, idling or braking and would be fed in to the system.

Option No.2:- In this Option, everything described under Option No.1 remains the same, except a 3Phase A.C. Induction Motor is employed instead of a D.C. Motor. Due to this, there would be some changes in the electrical / electronic modules / system described under Option No.1. Between D.C. Batteries Pack and A.C. Induction Motor, an Inverter to convert the Direct Current produced by the D.C. Batteries Pack to Alternating Current to feed the A.C. Induction Motor would be connected. Rest of the configuration remains the same as described under Option No.1.

N.B.: Instead of D.C. Generators, A.C. Generators can also be used. In that case, suitable electronic devices / gadgets need to be re-configured, like an A.C. to D.C. Converter plus D.C. to D.C. Converter would be required to be used

The vehicle will be started as any electric vehicle by switching the ON button on the Dash Board. The Automotive Power Drive System works as described below:

The D.C. produced by the D.C. Batteries Pack is fed to the D.C. Drive Motor through the D.C. Controller. The D.C. Motor will be operated on a power of 100 kW = (134 H.P.) and at 12,500 R.P.M. as determined by the D.C. Controller and D.C. Motor characteristics. The rotational energy of the D.C. Drive Motor is used to drive the Pulleys System. Pulley No.2 drives Fluid Couplings. They multiply the torque 2.5 times the input shaft torque, but at a reduced speed. The pulleys Nos.1 and 2 are designed in such a way that the output torque and speed are 252.3015kg.m / 504.603 kg.m (=2.5 x 100.92065kg.m) and 1765 R.P.M. respectively at the output of Pulleys. The same is fed to the Fluid Coupling and then to the D.C. Generators. The combined H.P. produced by the same works out to be = 951.278 H.P. (= 709.6533 KW). (See the Calculation Sheet).

D.C. produced by the Generators is transmitted through the D.C. to D.C. Convertor and D.C. Controller to the On - Board Smart Battery Charger and then, is, fed to the D.C. Batteries Pack. Electricity (D.C.) from the Auxiliary battery can be utilized for lighting up of the vehicle. In this unique design feature, it is **significant** that the vehicle runs from the power produced by the D.C. Generators and at the same time the excess power produced by innovative arrangement and exploitation of various equipment's unique technical features, the remaining power is fed back to the Batteries Pack through D.C. Gadgets such as D.C to D.C. Converter and D.C. Controller.

N.B.: In the case of A.C. Induction Motor, the D.C. produced by the D.C. Batteries Pack is fed to the D.C. to A.C. Inverter, which converts D.C. into A.C. The A. C. Induction Motor will be operated on a power of 100 kW (=134 H.P.) and at 12,500 R.P.M. as determined by the Inverter and A.C. Motor characteristics. As in the case of D.C. Motor and D.C. Generator, the torque of 252.3015 kg.m and speed of 1765 will be fed individually to the 2 A.C. Generators.

2.3 Protocol for Operation Manual:

I) **Phase I: (A) Start:** (1) **Connect** the Batteries Pack, D.C. to D.C. Converter and D.C. Controller to the D.C. Motor. (In the case of A.C. Motor, the D.C. will be converted to A.C. by the Inverter).
(2) **Start** D.C. Motor by pressing the "ON" button to **drive** the pulleys system. (In the case of other option, it is the A.C. Motor that will be started).
(3) Pulleys Nos.1 and No.2 are **running.**
(4) Fluid Coupling (T.C.) is rotating, producing torque that is 2.5 times the input torque, during 30 seconds of acceleration.
(9) D.C. Generators are **running**. Hence, they are **producing** power. (For other option, it is the A.C. Generators).
(10) Batteries Pack is **discharging**.

(B) Stop And Re - Start: (1) **Vehicle stops** when the traffic signal is "RED" or as per the timer signal.
(2) Signal is sent to the D.C. Controller to stop the D.C. Motor for 30 seconds and re – start the D.C. Motor after 30 seconds.(For other option, a signal will be sent to stop the A.C. Motor and re-start the same after 30 seconds).
(3) By re-starting the drive through the pre-set timer in a cyclic manner, the torque multiplication is achieved.

2.4 Significance of the system:

(i) The **Automotive Power Drive System** runs and produces power for running the vehicle as long as the system of Batteries Pack, D.C. Motor (or A.C. Motor, for other option) and D.C. Generators (or A.C. Generator, for other option) work and last.
(ii) This system would run till the Batteries life is over, which can be 15 - 20 years.
(iii) The most significant feature of this design is given below:
This same designed configuration of equipment / machineries can be used as a model for producing electric power independently of the power grid. The system will work as per the life defined by Batteries Pack and D.C. or A.C. Motors and D.C. or A.C. Generators. (See Option No.3 as well as Options Nos.4, 5 and 6).

.5 Calculation Sheet

(1) Batteries Pack + D.C. Motor: The configuration of the Batteries Pack would consist of several numbers of 12 Volts Lithium Ion Batteries of reputed make and giving a total voltage of 650 volts and Amperage of 300 Amperes. This D.C. Motor (or A.C. Motor for other option) gives us 100 KW (134 H.P.) and the torque = 30 kg.m.
(2) Pulley No.1 and No.2 with Belt System: The power produced by the D.C. Motor / A.C. Motor, as the case may be, will be transmitted to the Pulleys and Belt System. In this scheme, the Torque is increased, but the speed at the output shaft of the System is reduced. By using the standard formula, n1 x N1 x T1 = N2 x T2, we have, 0.95 x 12500 x 30 = 1765 x T2. (Where n1 = Efficiency of the Pulleys System = 95% and T2 is the Torque available at the output shaft of the System). Therefore, T2 = 0.95 x 12500 x 30 / 1765 = 201.8413 kg.m.
(3) Fluid Couplings: The torque and speed from the output shaft of Pulleys System is used to drive Fluid Couplings, which act as Torque Converters. The function of the Torque Converters is to multiply the input torque by 2.5. Thus, the output torque of the Torque Converters is = 2.5 x 201.8413 = 504.603 kg.m at a speed of 1500 R.P.M. as per the characteristics of the Torque Converters.
(4) D.C. Generators: The torque and speed at the input shafts of the D.C. Generators (or A.C. Generator as the case may be) are 504.603kg.m and 1500 R.P.M. respectively. Using the standard formula for the H.P., we have H.P. = 2 x 3.142 x N3 x T3 x n2 / 4500. (Where N3 = 1500 R.P.M., T3 = 504.603 kg.m. and n2 = Efficiency of the D.C. Generators (A.C. Generators for other option) = 90%). Substituting these values in the formula, we have, H.P. = 2 x 3.142 x 1500 x504.603 x 0.90 / 4500 = 951.277 H.P. (709.652 KW).

3 CONCLUSION

Power Evaluation Results

It will be worthwhile to account for power produced, power spent and what the net gain in power is. This will be done in relation to the **Phases**, that is, **I** and **II** as described above.
(Energy produced by the system per hour = + 709.652KWh. Therefore, for 100 hours, it will be = 70,965.20KWh = (709.652KWh x 100).
Thus, Energy produced and Energy spent are (+) 70,965.20 KWh and (-) 10,000 KWh
Respectively (100 KW x 100 hours from the Batteries Pack).
Therefore, the net Energy gain % over the Energy spent = (70,965.20 – 10,000 = 60,965.20 KWh). 60,965.20/10,000 x 100% = 609.65%. Say, 600 % (A rounded off figure). This is for 100* hour's work for D.C. Motor life.
(* How 100 hours' work time for D.C. /A.C. Motor is calculated? The acceleration time for torque multiplication is taken as 30 seconds. The flywheel stoppage time is taken as 15 minutes run. D.C. Motor's life is 3000 hours (= 180000 minutes). Hence, the calculation is based on this figure. The "starting and stopping" of

D.C. / A.C. Motor through a timer will occur for 12000 times (180000 / 15). Therefore, for 30 seconds acceleration time, it will be 12000 times x 30 seconds = 360000 seconds = 100 hours (360000 / 3600, since 1 hour = 3600 seconds).

N.B.:

1) The Sketch and Block Diagram of the Automotive Power Drive System alongwith the Equipment / Machineries is enclosed herewith. The sketches are not drawn to the scale.

The Innovative Idea presented in the above project report is conceptualized and designed by the under-mentioned Author of this Research Paper.

3) Please note this project report is a suggested scheme and is not to be considered as in the final stage of implementation. This paper gives a general idea how it can be implemented. For practical implementation of this project scheme, due modifications / changes may be or may not be required.

4) The Author and Originator of this project, Mr. Shashikant R. Salvi reserves his right to this innovative design as his own even after any modifications / changes and be compensated monetarily, which can be decided with mutual understanding. The envisaged scheme should not be used as it is or in any modified / changed form without permission of its author and originator.

OPTION NO.3:

In Option No.3, instead of 2 Nos. of Fluid Couplings, Flywheels, D.C. (or A.C.) Generators, only one set of each of above equipment would be used. Thus, the equipment list for the above option will be similar to TABLE "A" with some changes and will be as follows:

TABLE "B"

1) Batteries Pack (1 No. Pack).
2) D.C. Controller (1 No.).
3) D.C. Drive Motor (1 No.).
4) Pulley No.1 (1 No.).
5) Belt (1 No.).
6) Pulley No.2 (1 No.).
7) Plummer Block with Bearings (2 Sets).
8) Shaft for the Plummer Blocks and the Pulleys (1 No.).
9) Fluid Coupling (Torque Converter) (1 No.).
10) Flywheel (1 No.).
11) D.C. Generator (with double extension shaft) (1 No.).
12) Output Shaft of the D.C. Generator (1 No.).
13) On-Board Smart Battery Charger (1 No.).
14) D.C. to D.C. Converter (1 No.).
15) D.C. to A. C. Inverter (for other option) (1 No.).
16) Junction Box No.1 (1 No.).
17) Junction Box No.2 (1 No.).
18) Clutch (1 No.).
19) Gear Box (1 No.).
20) Electric Cables (1 Lot).

The principle of operation (Methodology), Protocol for Operation Manual, Calculation Sheet, and Conclusion will be similar to options1 and 2 described above. However, calculations will be made for one number of Fluid Coupling (Torque Converter), Flywheel and D.C. Generator. The conclusion will be same as given under Option No.1 and

Option No.2. While these 2 Options are solely for Electric Vehicles, Option No.3 is for Hybrid Type of vehicle, in which Clutch, Gear Box, Axle and Differential Gear Box will be used as in case of conventional vehicle.

The Automotive Drive under this Option (Scheme) No.3 is as shown in the Schematic and Block Diagram under **DIAGRAM 2.**

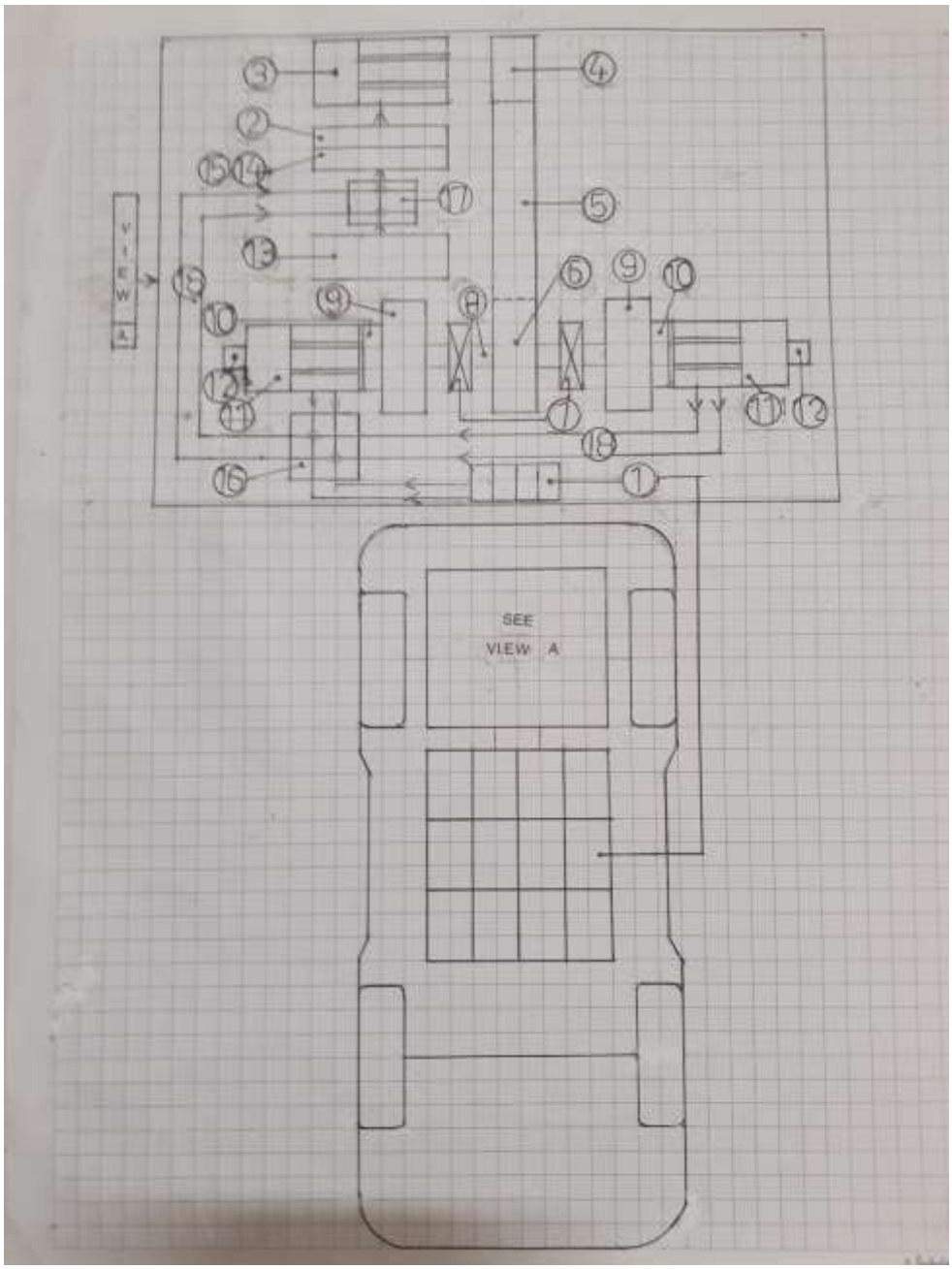
The Options given above, that is No.1, No.2 and No.3, can be extended to Options No.4, Option No.5 and Option No.6. These are described as under:

1) **Option No.4:** In this Option, the Batteries and its related equipment are not employed, but the Prime Mover will be a C.N.G. Engine.
2) **Option No.5** is similar to Option No.4, but the Prime Mover will be a Diesel Engine.
3) **Option No.6** is similar to Option No.4 and Option No.5; however, the Prime Mover will be a Petrol Engine.

In all the above Options, operating cost will determine which Option would be better. To give an example, the operating cost for a Diesel Genset of **100 KW** capacity would be **Rs. 2, 00,000/-** to **Rs. 2, 50,000/-** and the same would be between **Rs. 80,000/-** to **Rs. 1, 20,000/-** for **100 KW** for Battery Inverter System with the conventional methodology. By using the innovative methodology as enumerated above, it would be cheaper by 135%. As it can be seen that although Options Nos. 1, 2 and 3 are 40 to 48 % cheaper, the initial cost to set up the Genset units is higher than that required to set up other Gensets under Option Nos. 4 , 5 and 6.

The Automotive Drive System under these Options (Schemes) Nos.4, 5 and 6 will be similar to the one shown in the Schematic and Block Diagram under **DIAGRAM 2** with the exception being the absence of Axle and Differential Gear Box etc. The Clutch and Gear Box can be retained as they are, as optional. **DIAGRAM 1** (THE SCEMATIC AND BLOCK DIAGRAM FOR THE AUTOMOTIVE POWER DRIVE SYSTEM AND ALLIED MACHINERIES)

DIAGRAM 1(THE SCEMATIC AND BLOCK DIAGRAM FOR THE AUTOMOTIVE POWER DRIVE SYSTEM AND ALLIED MACHINERIES)



THE EQUIPMENT LIST

TABLE "A"

SR. NO.	DESCRIPTION	QUANTITY
1.	Batteries Pack	1 No. Pack
2.	D.C. Controller	1 No.
3.	D.C. Motor (or A.C. Motor)	1 No.
4.	Pulley No.1	1 No.
5.	Belt	1 No.
6.	Pulley No.2	1 No.
7.	Plummer Block with Bearings No.1and No.2	2 Sets
8.	Shafts for the Plummer Block Bearings and Pulleys	2 Sets
9.	Fluid Couplings / Torque Converters No.1 and No.2	2 Nos.
10.	Flywheels No. 1 and No.2	2 Nos.

11.	D.C. (or A.C. Generators) No.1 and No.2	2 Nos.
12.	Output shafts for transmission to wheels	2 Nos.
13.	On – Board Smart Battery Charger	1 No.
14.	D.C. to D.C. Converter	1 No.
15.	D.C. to A.C. Inverter (as per the second option)	1 No.
16.	Junction Box No.1	1 No.
17.	Junction Box No.2	1 No.
18.	Electrical Cables	1 Lot

TABLE "B"

SR. NO.	DESCRIPTION	QUANTITY
1.	Batteries Pack	1 No. Pack
2.	D.C. Controller	1 No.
3.	D.C. Motor (or A.C. Motor)	1 No.
4.	Pulley No.1	1 No.
5.	Belt	1 No.
6.	Pulley No.2	1 No.
7.	Plummer Block with Bearings No.1and No.2	2 Set
8.	Shaft for the Plummer Block Bearings and Pulleys	1No.
9.	Fluid Coupling / Torque Converter	1 No.
10.	Flywheel	1 No.
11.	D.C. (or A.C. Generators)	1 No.
12.	Output shaft for transmission	1 No.
13.	On – Board Smart Battery Charger	1 No.
14.	D.C. to D.C. Converter	1 No.
15.	D.C. to A.C. Inverter (as per the second option)	1 No.
16.	Junction Box No.1	1 No.
17.	Junction Box No.2	1 No.
18.	Clutch	1 No.
19.	Gear Box	1 No.
20.	Electrical Cables	1 Lot

DIAGRAM 2(THE SCEMATIC AND BLOCK DIAGRAM FOR THE AUTOMOTIVE POWER DRIVE SYSTEM AND ALLIED MACHINERIES) (OPTION NO.3).

