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Amplification and recirculation of output power in a compound gear train

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Abstract - *Conventional power generation since the discovery of currents in the 19th century has experienced challenges beyond generation alone. Electricity has been widely explored for its nature and interactions in space-time for development of the academic understanding of its behaviour, and that of its by-product force, magnetism. The growth of understanding of these energies has formed the basis for modern electricity generation and distribution infrastructure for the large-scale demand and its day-by-day growth. At our current level of technology, we have non-renewable power sources like coal-based and nuclear fuels, that are reliable and scalable, thus being the largest sources of electricity today. Electricity generated by these sources is, however, usable after numerous long-range transmissions and transductions to eventually achieve mechanical motions in appliances owned by end-users. The most common transducer of electricity to mechanical and kinetic are gears.*

While gears have been used widely in numerous fields like in the gearboxes of cars, trains, printers, various machinery for woodwork, pharmaceuticals, and many more, there is a use that this concept paper seeks to pave the application of gear concepts towards:

Renewable energy.

Simply put, it is common knowledge that gears are used for maximising torque and rotation speed. The solution proposed to be explored behind this concept paper is harnessing the power of gears to enhance revolution speeds for electricity production. The shaft rotation of a dynamo, tachogenerator, or any such device that transmutes mechanical energy and kinetic energy from rotation to useful electricity.

Key Words: *Gears, Motor, Dynamos, Alternators, Tachogenerator, Renewable energy.*

INTRODUCTION

Today energy requirement is growing faster than ever before, and the additional demand is for the new installed generating capacity to be environmentally friendly. The present geopolitical situation at the time of writing this paper as well as the 2015 Paris Climate Accords, which is a push for sustainable development, move the world demand from carbon-based power sources to nuclear and renewables.

While solar panels can be installed on roofs and privatise the energy generation process, reducing load on long distance electricity transmission, electricity is still distributed through centralised sources, including the three renewables through large swathes of land covered in solar panels, wind turbine towers, and hydropower dams.

The scalability and implementation of most renewables according to the recent report of the Intergovernmental Panel on Climate Change (IPCC), affect their acceptability and larger footprint in the renewable energy space. As such, new innovations in optimizing renewable power sources can be a solution for large scale implementation.

Objectives of this concept paper

This concept paper aims to explore the possibility of a system which can generate power as a space-efficient, portable, cost saving and decentralised source.

This concept paper aims to suggest the use of the gear train for purpose of revolution speed maximization. Also to quantify the degree and duration of mechanical energy transfer to the power generation components relying on rotational mechanical force for input. Under the condition that the due input is sourced from the same power generation components.

1. Literature Review

"Wind turbine gearboxes" by Energiforsk, 2016-2017: This research explored the concept of reliability effect of a gearbox in a wind turbine. Our research explores gearboxes and focuses on the overall apparatus capability to maintain a circular electricity flow without wind kinetic energy.

"Generation of electricity using gear watch mechanism without using fuel," March 2015. D.V Rojatkar, Mangesh Kore, Deepak Hatzade, Rahul Singade, and Suraj Khengar. This concept paper too, focuses on using a system that does not rely on fuel or renewable energy for revolutions. In our system, we do not consider worm wheels an optimum addition to the speed increases and there is no

involvement of hand crank for restarting the movement, rather, our apparatus is tested using no direct manual controls.

2. Brief description of some of the core components of the apparatus to test the theory

2.1 Motor

A motor is a system constituting of coil windings and permanent magnets in the rotor and stator. Together with bearings, they act as transducers of electrical energy to mechanical energy in industrial applications. Motors are compared with each other on, and their quality measured in, synchronous speed measured in revolution per minute, efficiency and the difference between the synchronous and full load speed known as the slip, measured in percentage. This concept proposes the usage of motors as the sole external force acting on the compound gear train setup, besides gravity, for setting it from inertia and conversion of electricity to mechanical energy for its sustained movement. Its electricity source will be the power generation component converting mechanical and kinetic energy from the gear train itself. It will be investigated in this research the duration for which it will be able to process the power supply from the power generation systems of the apparatus.

2.2 Gears

Gears have existed throughout the three industrial revolutions and have seen their family greatly expand over the centuries due to ever changing industrial needs. Different combinations of gear train have been invented to fulfil their purposes for speed control and torque optimisation. Gear trains have had been ideated in the performance of energy generation and storage systems but limited.

3. Current modes of power generation through rotation

3.1 Tachogenerator

Tachogenerators are portable devices that generate power proportional to their shaft speed. The faster the shaft is rotated, the higher the output voltage. Tachogenerators are used not for power generation but in a tachometer device. In this concept paper, the other idea we suggest is using tachogenerators for power production as the high revolutions per minute achieved by the end driven gears from the compound gear train body could translate to proportionally high electricity generation.

Tachogenerators are preferred for this purpose over dynamos and alternators for power production as tachogenerators can generate power in either alternating or direct current unlike dynamos and tachogenerators that only produce one kind of current.

3.2 Dynamos

Dynamos are similar portable devices that produce power from the rotation of shaft speed. The faster a dynamo shaft spins, the higher output voltage. From various observation, dynamos have not had a place in mainstream power generation. Dynamos have been used for power production in cycles from the speed of revolution achieved by the strength of the cyclist. Dynamos are essentially DC tachogenerators and have similar cross section.

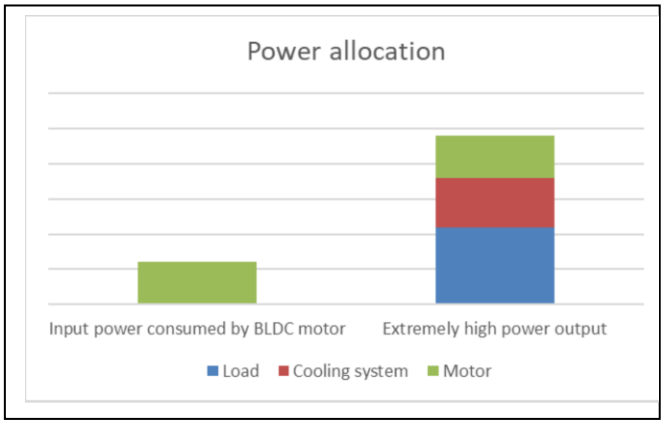
3.3 Turbines

Turbines are the most common mode of generating electricity from mechanical input in conventional power production. Turbines today are of three types: Wind turbines, Hydro turbines, and gas turbines. The most common are gas turbines whose blades are slanted and are longer at the end shafts of the turbine fan for accelerating gas flow and rotating from pressure applied by the flowing gas. The gas for turbines is gained from water vapour from boilers that receive heat from burning of fossil fuels, natural gas, hydrogen, biomass like ethanol and waste, or nuclear reactions like fission and fusion, for boiling water.

4. Working mechanism

The apparatus for verifying the applicability of the concept will use a compound gear train set-up, whose movement will be initiated and continued by a motor. A differently designed tachogenerator will be built for the purpose of power generation. The power will be directed to motor and target load. Various combinations of compound and planetary gear train design will be tested for maximum output of the power generation component.

5. Graph representing energy levels in input and output



6. Concept origin

This concept originated from the four-rotor drone design. Drones with rotors arms containing the spinning fans required for propulsion receive their power from a central battery pack. It was observed if the rotors fans could be connected to a large drivershaft gear, spinning a radially inferior driven shaft gear, connected to a rotary power dependent electricity source to charge the battery, it would lead to drone external power requirement to charge the battery to diminish substantially. This concept then concluded post-elimination of the requirement of lift and flight, and simply focus on the energy production and consumption patterns of the proposed set-up.

7. Experimentation

7.1 Process to ascertain applicability of the concept:

1. Gear ratios of driver and driven gears form a sumproduct shaft to shaft in compound gear trains.

   How:

- The individual driven gears set against each driven gear will be evaluated with a tachometer, separately.
- This will confirm that the value of the gear ratio, or mechanical advantage, does increase in powers of 2,3,4 in the ascending order of the shafts considered.

2. If the answer to the first question is yes, then can the high revolutions per second attained by the end driven gear be transferred to a component generating power from rotation?

   How:

- Will be derived from tachometer values in similar way as above.
- The gear ratios increasing in powers of 2,3,4 multiplied with the revolutions per minute of the motor has to be tested as this will derive the final revolutions per second values.
- Difference between the values from experimentation values and theoretical values will indicate the energy losses, and consequently the concluding useful revolution kinetic energy.

3. Based on the values from answering the third question, can the output power be distributed between the load and motor moving the driver gear sourcing the revolutions of the entire compound gear set-up?

   How:

- The power generation component will be a system converting rotational kinetic energy to electrical energy. So to evaluate the output, we will need voltmeter and ammeter to measure the final voltage and current output respectively from the revolutions.
- The cathode ray oscilloscope will be involved in case an alternating current is used to measure the frequency, amplitude, and phases of the signal.
- The measure of voltage, current, signal qualities, will most importantly be used for identifying the parameters of both the output electric signals split in two pathways to:
  a) the load aimed to be powered,
  b) and the motor causing spin in the system.

4. From the measurements of the two separate electric signals, we **confirm if the routed output power from the power generation component spun by the last shaft driven gear to the motor is high enough** and **consistent as input power for the maintaining of rotor spin for sustaining the entire compound gear train.**

   How:

- This will be timed for how long the system sustains and using current parameter assessing devices, the indicators of electric current will be constantly monitored to count energy losses.
- Further, it will be identified from the potential difference, current, electric signal frequency and phases if the system is able to meet household power requirements, and if yes, then the duration will be timed.

(See annexure for the final block diagram of the experimentation apparatus.)

8. Conclusion

To conclude, the current renewable energy generation landscape attracts a spectrum of opportunities for the scientific community to ideate solutions. Challenges like efficiency, implementation, and lack of scalability are being gradually overcome for replacing petroleum as an energy source. In this concept, an idea to use the simple gear train and employ its ability to magnify revolutions per minute is proposed that can lead to a higher power production for the growing power requirements of society.

This concept does not seek to suggest that law of conservation of energy has need of modifications or has failed to factor in the possibility that increased speed from gear trains can result in larger energy production from the system than its input. Rather, the concept seeks to explore further the behaviour of said apparatus suggested in this research and all interactions.

9. References

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10. Annexure

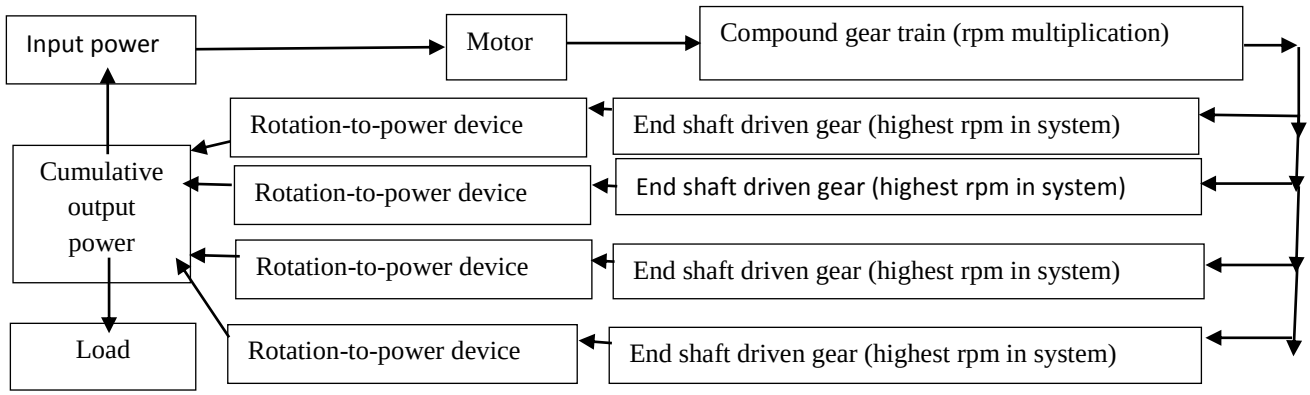

Figure 2.0: Block Diagram of Apparatus

Author Credentials

Vishrut Anand, private researcher. No organisational affiliation. He is highly passionate about renewable energy and developments in the large-scale adoption of solutions pertaining to their implementation and scalability. He seeks to actively pursue his research on one such ideated solution by him through and after the presentation of this paper.