INITIATED DISCHARGE DUE TO ROCKET ASCENSION (IN.D.R.A)

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ABSTRACT

Globalisation, Industrialization, increase in population and increase in the machine dependence has led to a tremendous increase in the power demand but the comparative generation of power is not up to the mark. Hydro power plants need lot of water flow, nuclear and thermal power plants need non renewable energy forms in tremendous amount as well as there are many safety precautions to be taken. Earth resources needed for power generation are depleting but the demand of power is increasing! Its the cry of the hour to find out either an alternative power source or an alternative resource for power generation. Trapping and harnessing of natural electricity i.e. lightning with the help of rocketry and basic electrical concepts of conductors and capacitors this alternative of power generation resources as well as an alternative of power can be generated. This power generation includes study of chemical properties of substances, stress and strain i.e. the bearing capacity of metals, combustion properties of the fuels (chemicals) and electrical properties of conductors and capacitors. It includes calculation work for a proper functioning as well as designing of the research project.

***Keywords*: Globalization, Non Renewable Resource, Depletion, Alternative Power Supply, Lightning, Natural Electricity, Trapping and Using.**

I. INTRODUCTION

A rocket is a missile, spacecraft, aircraft or other vehicle that obtains thrust from a rocket engine. Rocket engine exhaust is formed entirely from propellants carried within the rocket before use. Rocket engines work by action and reaction. Rocket engines push rockets forward by expelling their exhaust in the opposite direction at high speed. Rockets rely on momentum, air foils, auxiliary reaction engines, gimbaled thrust, momentum wheels, deflection of the exhaust steam, propellant flow, spin, and/or gravity to help control flight.

Rockets are relatively lightweight and powerful, capable of generating large accelerations and of attaining extremely high speeds with reasonable efficiency. Rockets are not reliant on the atmosphere and work very well in space. Chemical rockets are the most common type of high power rocket, typically creating a high speed exhaust by the combustion of fuel with an oxidizer. The stored propellant can be a simple pressurized gas or a single liquid that disassociates in the presence of a catalyst (mono propellants), two liquids that spontaneously react on contact (hypergolic propellants), two liquids that must be ignited to react, a solid combination of one or more fuels with one or more oxidisers (solid fuel).

II HISTORY

Rockets for military and recreational uses date back to at least 13th century China. Significant scientific, interplanetary and industrial use did not occur until the 20th century, when rocketry was the enabling technology for the Space Age, including setting foot on the moon. Rockets are now used for fireworks, weaponry, ejection seats, launch vehicles for artificial satellites, human space flight, and space exploration.

1232: A common claim is that the first recorded use of a rocket in battle was by the Chinese in 1232 against the Mongol hordes at Kai Feng Fu.

1792: In 1792, the first iron-cased rockets were successfully developed and used by Hyder Ali and his son Tipu Sultan, rulers of the Kingdom of Mysore in India against the larger British East India Company forces during the Anglo-Mysore Wars.

1926: On 16 March 1926 Robert Goddard launched the world's first liquid-fueled rocket in Auburn, Massachusetts.

1943: In 1943, production of the V-2 rocket began in Germany. It had an operational range of 300 km (190 mi) and carried a 1,000 kg (2,200 lb) warhead, with an amatol explosive charge.

Current Day: Rockets remain a popular military weapon. The use of large battlefield rockets of the V-2 type has given way to guided missiles. However rockets are often used by helicopters and light aircraft for ground attack, being more powerful than machine guns. Shoulder-launched rocket weapons are widespread in the anti-tank role due to their simplicity, low cost, light weight, accuracy and high level of damage.

III PROJECT WORK

The project aims at the generation of electricity by harnessing and trapping of the natural electricity i.e. lightning!

The project works on the principles of rocketry and aeronautics. Properties of conducting materials is at a great use here in this project.

3.1 Principle of Working

Aerodynamic bodies and aeronautics basic principles along with conducting capacity, heat bearing capacity, energy storing capacity of conductors and capacitors are used. The basic principles and laws of general physics and Electrical engineering are used.

3.1.1 Rocketry

The rocket motor we use in this project is a rocket motor which has a solid combination of one or more fuels with one or more oxidisers i.e. a solid fuel rocket motor.

1)Types of Solid Fuel Rocket Motors:

A) B-200 (“H”- Class)
B) C-400 (“I”- Class)
C) A-100 (“G”- Class)
D) A-100M (“G”- Class)

There are various other types of solid fuel rocket motors used but the widely used motors are the ones given above. The class of the rocket is determined according to the fuel used, thrust produced, and the distance covered by the rocket. The solid fuel rocket motors consist of various types of propellants [1].

3.2 Types of Propellants

a) Potassium Nitrate/ Sucrose Propellant (KNSU)
b) Potassium Nitrate/ Dextrose Propellant (KNDX)
c) Potassium Nitrate/ Sorbitol Propellant (KNSB)

Our project work includes the use of C-400 motor and KNSU propellant.

3.2.1 C-400 Solid Fuel Rocket Motor:

The C-400 rocket motor was developed in 1973 (originally as the C-II motor), a few months after the B-200 motor was developed. Its purpose was intended for boosting somewhat heavier rockets equipped with small payloads, as well as for proof testing of the parachute deployment method with higher altitude flights. It was expected that the rocket would achieve a peak height of about 2500-3000 feet (750-900 metres).

The thrust function for this motor is shown in Figure 1 below, achieving a maximum thrust of 325 pounds (1445 Newtons), and a total thrust time of 0.50 seconds. The total impulse is 106 lb-sec (470 N-s), which fits it into an " H " class designation. The high thrust combined with a short burn time provides for very quick acceleration of the rocket, which is beneficial for providing rapid aerodynamic stability of the rocket vehicle after departing the launch guide-rod. Having a free-standing grain, burning is completely unrestricted, meaning the hollow cylindrical grain burns on both inner and outer surfaces, as well as both ends. The performance graph was based on results from a static test of the motor (AST-13).

The performance of the motor is significantly influenced by the igniter. Non-pyrotechnic ignition would result in lower delivered impulse, lower maximum thrust, and an extended burn time (longer thrust build up duration). This motor is capable of boosting a 3 inch (7.6 cm) diameter rocket, with a mass of 5.5 lbs (2.5 kg), to an altitude of over 3000 feet (900 metre) (this was typical of the rockets which I launched). If the rocket diameter is reduced to 2 inch (5 cm), the same rocket powered by the C-400 motor would achieve a peak altitude of close to 4000 feet (1.2 km) [1].

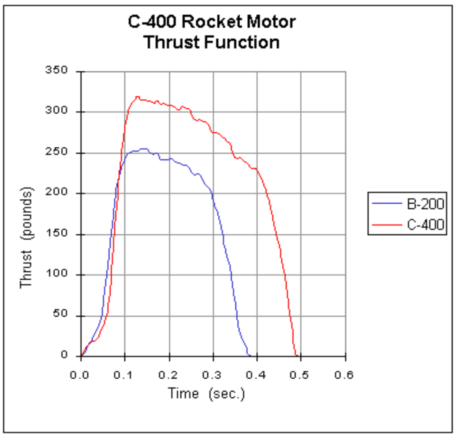

Fig. 1 C-400 Motor performance graph, with the B-200 motor performance shown for comparison

3.3 Designing of the C-400 Rocket motor

3.3.1 Nozzle

The C-400 nozzle is a conical profile, convergent-divergent, supersonic type. It has a 30 degree convergence angle, and a 12 degree divergence angle, and has an area expansion ratio of 16.8. It is machined from a single piece of cold-rolled (CR) steel bar stock, with polished inside flow surfaces. Of particular importance is the throat region, being the most critical with regard to motor performance. The nozzle contour is rounded at the throat to avoid sharp discontinuities in profile. The nozzle has a groove machined around the outer perimeter of the convergent section, to provide a recess for the nozzle retention screws. Six 1/4 inch hi-strength set screws, which engage into threaded holes in the casing, retain the nozzle. The nozzle is not normally removed once installed (propellant is loaded at the head end). To reduce leakage between the nozzle and casing, the casing is "rolled" around its circumference (after insertion of the nozzle) utilising a customised tool which effectively reduces the casing diameter locally, providing a nearly gas-tight seal. This tool is essentially the same as a constrictor *tool*, as used in HVAC applications. Filling the nozzle groove with silicone RTV will further reduce the likelihood of gas leakage.

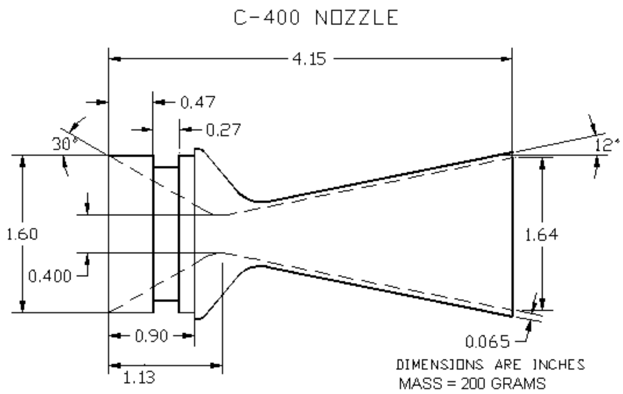

Fig. 2 Details of C-400 nozzle

3.3.2 Casing

The casing is made from seam welded steel tubing, specifically 1-1/2" Electrical Metallic Tubing (EMT).

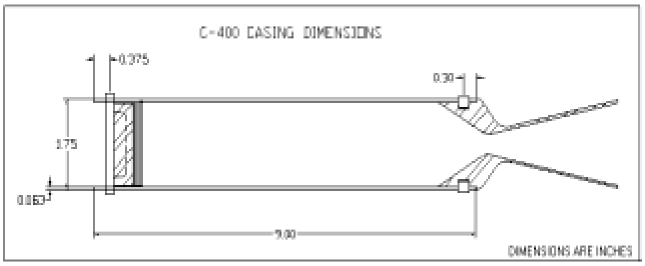

Fig. 3 C-400 Motor casing dimensions

3.3.3 Motor Head

The head is shown in detail in Figure 4.

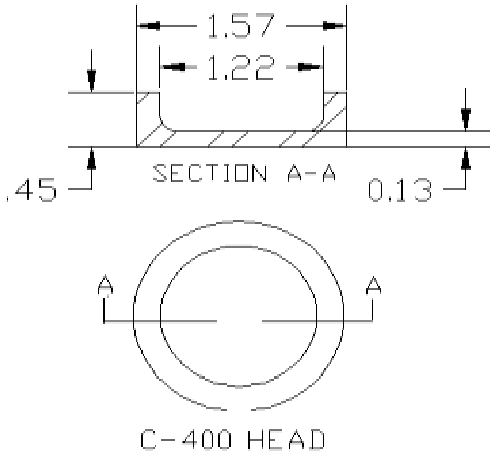

Fig. 4 Details of C-400 head **Fig. 5 Details of C-400 safety pin arrangement**

3.3.4 Propellant Grain

The C-400 motor is meant to be powered by KN-Sucrose propellant , cast as a hollow cylindrical free-standing grain, with unrestricted burning (i.e. all surfaces of the grain burn). The hollow core is normally 9/16 inch (1.43 cm) diameter. The maximum grain capacity is 380 grams. The grain is cast to size such that it is a slightly loose fit, and is loaded into the motor from the head end. Typical grain diameter is 1.58 inch (4.0 cm), and typical length of the cylindrical portion is 7 inch (17.8 cm). The steady-state burn profile is slightly regressive, with the (ideal) burning surface area initially 54 in^2 decaying to 47 in^2 prior to web burn through. This gives a Kn range of 430 (initial) and 370 (final).

Standard Composition (65/35 O/F): For the KN-sucrose propellant, with an oxidiser-fuel (O/F) ratio of 65/35, the theoretical combustion equation is as follows:

C12H22O11 + 6.288 KNO3 -> 3.796 CO2 + 5.205 CO + 7.794 H2O + 3.065 H2 + 3.143 N2 + 2.998 K2CO3 + 0.274 KOH at a pressure of 68 atmospheres, and where the following compounds are symbolised as:

TABLE I

Molecular Formulae for Components Of Propellant

sucrose	solid	$C_{12}H_{22}O_{11}$
potassium nitrate	solid	KNO_3
carbon dioxide	gas	CO_2
carbon monoxide	gas	CO
steam	gas	H_2O
hydrogen	gas	H_2
nitrogen	gas	N_2
potassium carbonate	liquid	K_2CO_3
potassium hydroxide	gas	KOH

3.5 Lightning

Lightning is a powerful sudden flow of electricity accompanied by thunder that occurs during an electric storm. The discharge will travel between the electrically charged regions within a thundercloud, or between a cloud and a cloud, or between a cloud and the surface of a planet. The charged regions within the atmosphere temporarily equalise themselves through a lightning flash, commonly referred to as a *strike* if it hits an object on the ground. There are three primary types of lightning; from a cloud to itself (intra-cloud or IC); from one cloud to another cloud (CC) and between a cloud and the ground (CG). Although lightning is always accompanied by the sound of thunder, distant lightning may be seen but may be too far away for the thunder to be heard. Many factors affect the frequency, distribution, strength and physical properties of a "typical" lightning flash in a particular region of the world. These factors include ground elevation, latitude, prevailing wind currents, relative humidity, proximity to warm and cold bodies of water, etc. To a certain degree, the ratio between IC, CC and CG lightning may also vary by season in middle latitudes. Lightning is usually produced by cumulonimbus clouds, which have bases that are typically 1–2 km (0.6-1.25 miles) above the ground and tops up to 15 km (9.3 mi) in height [2].

3.5.1 Establishing conditions necessary for lightning

In order for an electrostatic discharge to occur, two things are necessary: 1) a sufficiently high electric potential between two regions of space must exist; and 2) a high-resistance medium must obstruct the free, unimpeded equalisation of the opposite charges [2].

Fig. 6 Invoking and carrying of lightning using a conductor

3.5.2 Trapping Of Lightning

For trapping of light we need a conductor from the trapping point to the device where it is being trapped. So, here we use copper wire as a conductor. Copper being a very good conductor of electricity and as it is cheaply and abundantly available, he use of copper is most suitable for the project [3].

Fig. 7 Copper wires and Copper cables

The device used for trapping of any charge, current is known as a capacitor and the property to trap charge is known as capacitance [4].

1) Capacitance:

When a charge is delivered to a conductor its potential is raised in proportion to the quantity of charge given to it. At a particular potential a conductor can hold a given amount of charge. Capacitance *is the term to indicate the limited ability to hold charge by a conductor.*

Let charge given to a conductor be = q
Let V be the potential to which it is raised [5,6].

Then,

q = CV

C is constant for a conductor depending upon its shape size and surrounding medium. This constant is called capacitance of a conductor.
If V = 1 Volt than C = Q, thus capacitance is defined as the amount of electric charge in coulomb required to raise its potential by one volt.
If V = 1 Volt than C = Q, and Q = 1 Coulomb than C = 1 Farad thus one Farad is capacitance of a capacitor which stores a charge of one coulomb when a voltage of one volt is applied across its terminal.

2) Capacitor:

A capacitor or condenser is a device for storing large quantity of electric_charge. Though the capacity of a conductor to hold charge at a particular potential is limited, it can be increased artificially. Thus any arrangement for increasing the capacity of a conductor artificially is called a capacitor. Capacitors are of many types depending upon its shape, like parallel plate, spherical and cylindrical capacitors etc. In capacitor there are two conductors with equal and opposite charge say +q and –q. Thus q is called charge of capacitor and the potential difference is called potential of capacitor.

3) Principle of capacitor:

Let A be the insulated conductor with a charge of +q units. In the absence of any other conductor near A charge on A is +q and its potential is V. The capacity of conductor A is therefore given by:

C = qV

If a second conductor B is kept closed to A than electrostatic induction takes place. –q units of charge are induced on nearer face of B and +q units of charge is induced on farther face of B. Since B is earthed the charge +q will be neutralised by the flow of electrons from the earth.

Potential of A due to self charge = V
Potential of A due to –q charge on B = -V'
Thus net potential of A = V + (-V') = V -V' which is less than V
Hence potential of A has been decreased keeping the charge on it fixed, hence capacitance has been increased. With the presence of B the amount of work done in bringing a unit positive charge from infinity to conductor A decreases as there will be force of repulsion due to A and attraction due to B. Thus resultant force of repulsion is reduced on unit positive charge and consequently the amount of work doe is less and finally due to this potential of A decreases. Therefore capacity of A to hold charge (Capacitance) is increased.

4) Dielectric Strength:

The material between the two conductors A and B as shown in figure above is always some dielectric material. Under normal operating conditions the dielectric materials have a very few free electrons. If the electric field strength between a pair of charged plates is gradually increases, some of the electrons may be detached from the dielectric resulting in a small current.

When the electric filed strength applied to a dielectric exceeds a critical value, the insulating properties of the dielectric material gets destroys and starts conducting between the two conductors A and B. This is called breakdown of dielectric which is fault condition for a capacitor bank. The minimum potential gradient required to cause such a break down is called the dielectric strength of the material. It measures the ability of a dielectric to withstand breakdown.

It is expressed as kV/mm. ss It is reduced by moisture, high temperature; aging etc. Below table gives dielectric strength of some.

TABLE II

DIELECTRIC STRENGHTH OF VARIOUS MATERIALS

Dielectric Material	Dielectric strength [kV/mm]
Air	3
Impregnated Paper	4 – 10
Paraffin Wax	8
Porcelain	9 – 20
Transformer Oil	13.5
Bakelite	20 – 25
Glass	50 – 120
Micanite	30
Mica	40 – 150

Dielectric Strength for capacitor is the maximum peak voltage that the capacitor is rated to withstand at room temperature. Test by applying the specified multiple of rated voltage for one minute through a current limiting resistance of 100 Ω per volt.

Fig. 8 A commercially used capacitor

Fig. 9 Block of commercial used capacitors

3.6 Calculations

- Electricity/ charge transferred during a single strike of lightning = 3 X 10^6 Volts.
- Resistance offered by the copper wire in the terms of specific resistivity = 1.78 X 10^{-8}
- Heat Loss during the transfer of charge = 10^5 J
- Therefore according to the Ohms law and by exempting the effect of heat, the power stored in the capacitor bank in just a single lightning is 3.3 X 10^6 W [7].

IV FUTURE SCOPE AND BENEFICIARIES

The power generated works as the best alternative to the power generated using non renewable resources. In the upcoming years the non renewable resources will get depleted and we will run short of power so such projects will serve the best at such times.

The project is beneficial for the under developed countries as well as developing countries. The production cost of the electricity using rockets is comparatively very less than the cost required for the production of hydro power as well as thermal and nuclear power. This type of power will be very useful for the villages and places in remote areas. This type of project is beneficial to every country using it.

V CONCLUSION

Thus upon further studies and development the need for the alternative and cheap power resource can be achieved. The proper use of conductors, study of the basic electrical properties of different materials, chemical composition and combustion properties of various chemicals and study of functioning of aerodynamic structures is done. Thus, the desired results are obtained.

VI ACKNOWLEDGMENT

Research on a specific topic as well as its project work takes a lot of efforts. The various components of the project require help from various people. In the making of the rocket components an intense amount of energy and guidance is required.

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