

**Design of Multipurpose Pressure Regulated Blower Vacand Study  
of Leaf Briquettes**

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**Abstract**

Air is the abundant, cheapest and most widely available fluid. So, we decided to utilize the air, by the significance of pressure difference and the effect of friction of air, for various cleaning purposes. Already, we are using air as a working fluid in blower and vacuum cleaner separately. Here, we designed a machine which combines blower and vacuum cleaner in a single setup. Now a days, cleaning the fallen leaves is being done by manned work. To avoid the same,

we proposed the design which can collect fallen leaves and also blow away small dust particles. It will also shred the leaves into smaller particles. Leaves being a bio waste can be utilised in many alternative applications. But leaves are not considered seriously and they are totally wasted. So, we designed and fabricated an essential society-oriented machine which has the tendency to overcome the above mentioned problems. Also, we have studied the reasons for leaf briquettes and its properties.

**Keywords:** Air, Pressure difference, Friction, Blower, Vacuum cleaner, leaves.

## **I- INTRODUCTION**

### **(1) Vacuum cleaner:**

A vacuum cleaner is a device that uses an air pump (a centrifugal fan in all but some of the very oldest models), to create a partial vacuum to suck up dust and dirt, usually from floors, and from other surfaces such as upholstery and draperies. The dirt is collected by either a dust bag or a cyclone for later disposal. Vacuum cleaners, which are used in homes as well as in industry, exist in a variety of sizes and models—small battery-powered hand-held devices, wheeled canister models for home use, domestic central vacuum cleaners, huge stationary industrial appliances that can handle several hundred litres of dust before being emptied, and self-propelled vacuum trucks for recovery of large spills or removal of contaminated soil. Specialized shop vacuums can be used to suck up both dust and liquids.

### **(2) Blower:**

A centrifugal fan is a mechanical device for moving air or other gases. The terms "blower" and "squirrel cage fan" (because it looks like a hamster wheel) are frequently used as synonyms. These fans increase the speed of air stream with the rotating impellers. They use the kinetic energy of the impellers or the rotating blade to increase the pressure of the air/gas stream which in turn moves them against the resistance caused by ducts, dampers and other components. Centrifugal fans accelerate air radially, changing the direction (typically by 90°) of the airflow. They are sturdy, quiet, reliable, and capable of operating over a wide range of conditions.

### **(3) Blower Vac:**

A Blower vac is a machine which is a combination of blower and vacuum cleaner. During blower mode, it can blow up the air with higher velocity and during vacuum cleaner mode, it can suck up the air at higher velocity. A forward/reverse switch can accomplish the change of mode. This machine could suck in leaves and small twigs via a vacuum and blow up leaves via a blower.

## **II- LITERATURE REVIEW**

### **1. Vacuum-cleaner**

**John Vogelzangs, Frank E Morgan, Patent no. US 1048009 A Dated: 24.12.1912.**

This invention relates to vacuum cleaners for use in cleaning-streets and the like, the principal object of the invention being to improve that class of machines that utilize a practically continuous circulation of air for the purpose of conveying dust and dirt from the surface being cleaned to a receiver wherein the dirt and dust is separated from the current of air and said current permitted' to flow back to a point where it can again proceeds, the invention resides in the combination and arrangement of parts and in the details of construction hereinafter described and claimed, it being understood that changes in the precise embodiment of the invention herein disclosed can be made within the scope of what is claimed, without departing from the spirit of the invention.

### **2. Centrifugal blower with asymmetric blade spacing**

**Connor R. Duke, Jesse T. Dybenko, Patent no. US20120321494 A1 Dated: 20.12.2012.**

A centrifugal blower having asymmetrical blade spacing with acceptable balance. The asymmetrical blade spacing is determined according to a set of desired acoustic artefacts that are favourable and balance that is similar to that found with equal fan blade spacing. In one embodiment, the fan impeller can include thirty one fan blades. The invention relates to portable electronic products, and more particularly, to blowers or fans particularly suitable for use in air cooling systems of portable electronic products.

### **3. Blower vacuum,**

**Chandler Michael Baker,; Phoenix Harold Coleman, Patent no. US5222275 Dated:  
22.05.1992.**

A portable hand-held blower vacuum apparatus having a hinged inlet cover with a handle disposed at one end of the cover. The cover is moveable between a closed position where the cover spans an air inlet opening and an open position to allow insertion of a vacuum tube in to the inlet opening. The handle is used to move the cover between the open and closed positions. Air flows into the inlet opening through a screen in the cover, through accurate slots in a tubular extension of the inlet opening and over a circumferentially extending rib formed on the cover. In an alternative embodiment, a dedicated blower is provided in which a solid, stationary cover spans the inlet opening.

#### **4. Impeller for use with portable blower/vacuums,**

**Steven j. Svoboda, Patent no. Us6629818 b2 dated: 07.10.2003.**

A fan for a vacuum cleaner has a fan housing, a motor and an impeller. The fan housing has an inlet, an outlet, a scroll-shaped side wall, a back wall and a flat front wall. The impeller has a hub and multiple blades. The blades have a leading edge that is tapered upward, a top edge that is tapered downward, and a trailing edge that is tapered downward. Such tapering of the top edge and trailing edge provides less noise and better durability without diminishing air performance.

### **III- METHODOLOGY**

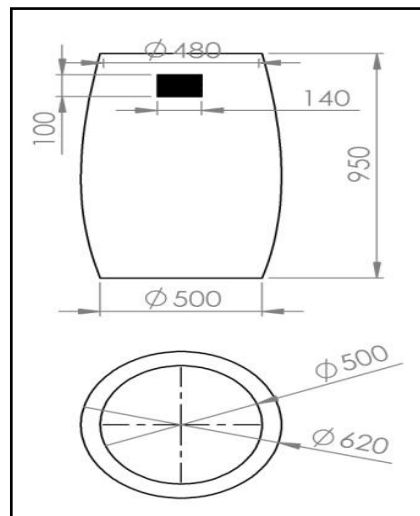
We have designed our machine to combine the blower and vacuum cleaner in a single setup. This machine can be used to suck fallen leaves and dust particles and blowing of leaves, sand and dust particles in an organisation like educational institutions or in public places like parks etc.,. In simple words, this machine can be used for outdoor cleaning purpose. In our machine, an AC induction motor is used as a prime mover for the impeller. The motor is made to drive in both direction by means of reversal switch.

We have used a gear drive to increase the speed of the impeller for greater air flow. With the help of the dimmerstat, we can vary the motor speed in order to achieve the different pressures for suction and blowing process. These pressures can be calculated according to pressure drop due to different hose length. An impeller with blades is connected to the shaft from gear assembly which will rotate to create the pressure difference between the outside and inside

of the machine. The blades in impeller will cut the leaves into smaller particles. This increases the storage volume of the collecting drum. A drum is used for collection of sucked materials. A trolley is used for the movement of the machine.

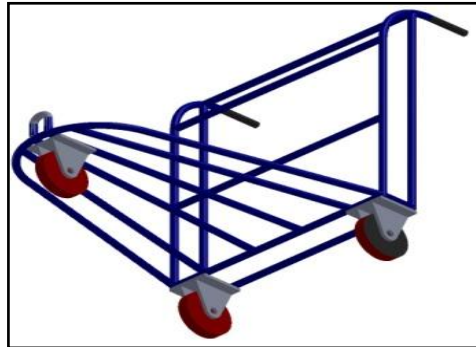
#### IV - COMPONENTS' DESCRIPTION

##### (1)PVC Drum:



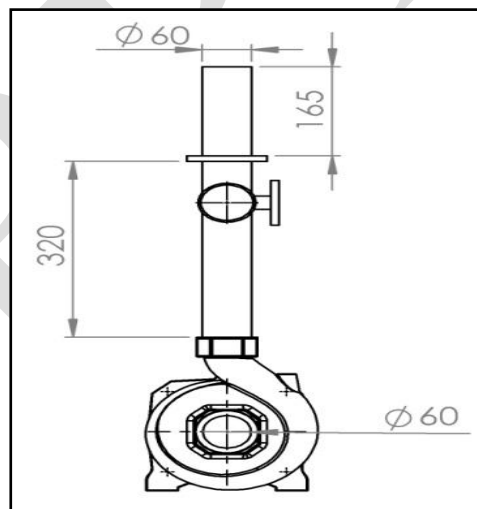
A PVC drum, also known as Polyvinyl Chloride tank, is most commonly used to store water. Here in our design, we used it to store the leaves what we suck using vacuum cleaner. It will have an air vent made of filter material to allow the flow of air and also to resist the leaf particles from inside to outside of the drum. It will also serve as an indicator to whether to dump the collected particles. Polyvinyl Chloride, more correctly but usually Poly(Vinyl Chloride), commonly abbreviated PVC, is the third most widely produced synthetic plastic polymer, after polyethylene and polypropylene.

**(2) Trolley:**



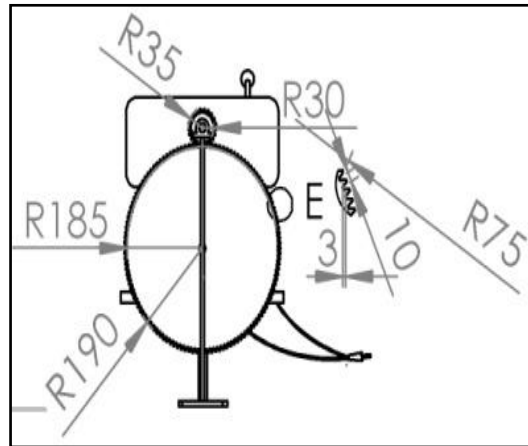
Trolley, also known as a trolley, is an L-shaped box moving handcart with handles at one end, wheels at base, with a small ledge to set objects on, flat against the floor when the hand-truck is upright. They are usually designed from tow extruded aluminium channel side rails and cast aluminium or magnesium parts. Here, trolley is used for the movement of the machine and also to hold the machine on it.

**(3) Impeller and its Casing:**



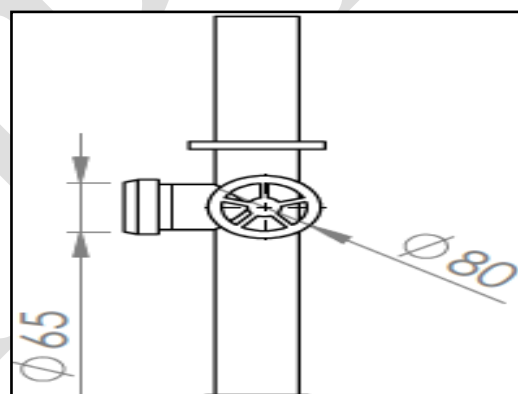
An impellor is the main component of the machine. It should perform both the operations of suction and blowing. It would have blades or jaws to cut the leaves into smaller particles. It is specially designed for our requirement. An impeller casing is the casing that covers the impellor. It further increase the pressure and velocity of air coming from impeller.

**(4) Motor:**



A motor is used as prime mover which assembly. In our project single phase 2HP 240V Induction motor of 2880rpm is used. Usually, normal vacuum cleaner would use universal motor to attain higher speed of 3600 to 5000rpm. But it have lot of limitations to use the same universal motor for outdoor purpose. Universal motor would produce high heat and so it cannot be produce high heat and so it cannot be operated continuously. Also it life was short. But we can overcome these limitations by using induction motor. We designed to increase the performance of induction motor equal to universal motor by means of gear setu

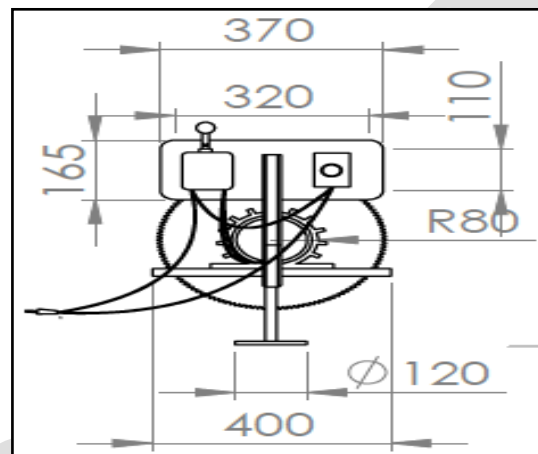
**(5) Gear Assembly**



A gear assembly is used to transmit the rotary motion from the motor shaft to the impeller with increased speed/rpm. In our project/machine, we planned to increase the speed in the ratio of 1.7 and to take trails at which speed the suction of leaf or other particles suck or blow

according to different hose lengths. We have used two spur gears of different sizes of same module. The bigger gear is called driver gear and the smaller gear is called driver gear. The driver gear has 127 teeth and is attached to the motor shaft. The driver gear has 18 teeth and is attached to the impeller shaft. These two gears are assembled to mate each other during operation of the machine, so that one full rotation of the driver gear would make the driver gear to rotate 7 times of driver which was in the speed ratio of 1:7 which was earlier mentioned. This spur gear supports the shafts in parallel with both clockwise and anticlockwise direction.

**(6) Dimmerstat:**



The basic Dimmerstat is meant for operation from a nominal input voltage of 240V 1ph ac & can give output voltage anywhere between 0 to 240V or 0 to 270V ac by simple transformer action. Because of this, speed of the motor would be changed according to Ohm's law ( $V=IR$ ). By increasing the voltage from 0 to 240V, we can identify the motor speed/rpm at which the suction takes place and then we may be able to standardise for different hose lengths.

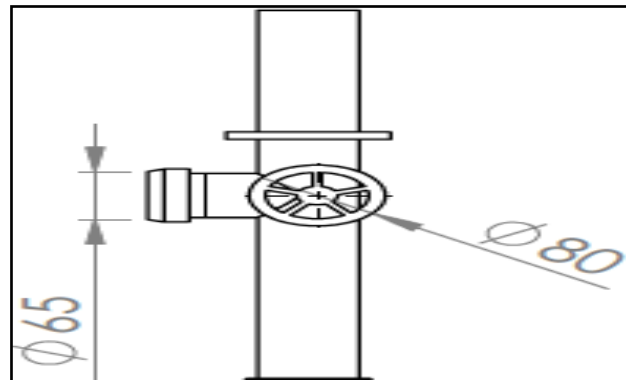
**(7) Reversing Switch:**

A DPDT switch has six connections, but since polarity reversal is a very common usage of DPDT switches, some variations of the DPDT switch are internally wired specifically for polarity reversal. These crossover switches only have four terminals rather than six. Two of the terminals are inputs and two are outputs. Generally, Reversing/DPDT switch is used for 3 phase motor which have applications in industrial machines. But in our project, we have used this



switch in single phase motor. This we done by connecting the condenser with the reversing switch.

**(8) Bypass Valve:**



In our design, a bypass valve is provided in the pipe between impeller casing and the lid. It bypasses the air flow/air circulation. It helps to use both vacuum cleaner and blower simultaneously. When we vacuum leaves, it gets collected in drum. Once we switch over to blower mode, air flow reverses and collected leaves would again come outside. So to avoid this, the bypass valve changes the direction of air flow during mode change. The bypass valve used here is Ball valve.

**(9) Hoses and Nozzle:**

Hoses are used to collect leaves from a certain distance away from machine. Nozzle is used to increase the pressure and velocity of air during the pressure and velocity of air during suction. Also, the nozzle acts as diffuser during blowing which decreases the pressure and velocity of air.

**(10) Supporting Components:**

**(i) Flange:**

A flange is used to support the weight of the whole assembly. During its operation, heavy vibrations are produced. Theses vibrations could be absorbed by Flange. Flange here used is made of Iron.

**(ii)Fasteners:**

A fastener is a hardware device that mechanically joins or affixes two or more objects together. Fasteners can also be used to close a container such as a bag, a box, or an envelope; or they may involve keeping together the sides of an opening of flexible material, attaching a lid to a container, etc. Fasteners used in these manners are often temporary, in that they may be fastened and unfastened repeatedly.

**V- CONSTRUCTION AND OPERATION**

**(1)Construction:**

The PVC drum is placed on the trolley. On the lid of the drum,, motor is placed at a certain height using flange Dimmers and reversing switch are connected with the motor. The driver gear is keyed with motor shaft and driven gear is keyed with impeller shaft. The impeller shaft is supported by means of roller bearing and supporting frame. The driver and driven gear are positioned to mate together. The impeller and its casing is coupled with impeller shaft. The pipe with by-pass valve is connected between the impeller casing and the storage drum. The hose with nozzle is fixed with impeller casing. The drum should held tight to avoid slipping from trolley by means of belt.

**(2)Operation:**

It functions two different operations, namely

- Vacuuming
- Blowing

**(i) Vacuuming:**

When the reversing switch is moved towards forward position, there is a difference in pressure created at different points. There will be low pressure at the front of impeller and high pressure at the atmosphere. Due to this, air is sucked in by the nozzle. Because of friction leaves also sucked along with air. The blades in the impeller shreds off the leaves. Then the air after passing the impeller attain higher pressure than the atmosphere. So the air would pass through the air vent provided in the drum leaving the leaf particles inside the drum.

**(ii)Blowing:**

During blowing operation, bypass valve should be turned off to blowing mode otherwise leaves will be disposed off when the reversal switch is turned when the reversal mode, the motor will change its direction of rotation (i.e.) clockwise to anticlockwise direction. This changes the pressure difference in opposite manner. There will be low pressure in the bottom of impeller and so air from atmosphere at higher pressure enters into the casing through by pass valve. Then air attains higher pressure in front of impeller and moves out with higher pressure to the low pressure atmosphere through diffuser.



**Construction**

## **CALCULATION**

### **(1) Gear calculation:**

We know that, for spur gear,

$$N_1 Z_1 = N_2 Z_2$$

Where  $N_1$  = Speed of driven gear in Rpm

$N_2$  = Speed of driver gear in Rpm

$Z_1$  = Number of teeth in driven gear

$Z_2$  = Number of teeth in driver gear

We know the parameters  $N_1 = 2880$  rpm;  $N_2 = 20000$  rpm;  $Z_1 = 17$  teeth

$$Z_2 = \frac{20000 \times 17}{2880} = 121.428$$

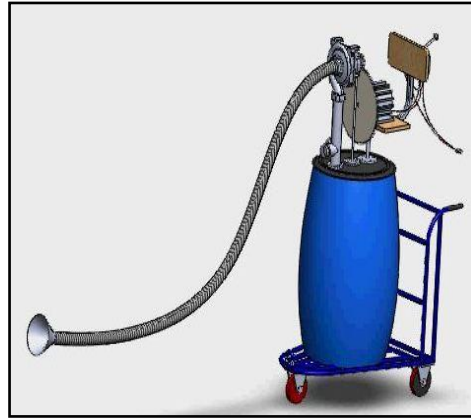
Std. Gear teeth in driver = 127 teeth.

## **VI - APPLICATIONS, ADVANTAGES AND LIMITATIONS**

### **(1) Applications:**

Cleaning processes in places like

1. Gardens
2. Indoor stadium
3. Playground
4. Laboratory
5. Classroom
6. Park etc.,



**Assembled Parts**

**(2) Advantages:**

- Easy to clean the leaves and dust particles at a same time.
- Fallen leaves can be used efficiently for making briquette, for cooking etc.,
- By keeping the machine in single place, we can use both vacuum cleaner and blower around its radius with the help of hose.
- It is easy to regulate the pressure of suction and blowing of air.
- It is multipurpose cleaning equipment.
- It is easily portable with the help of trolley.

**(3) Limitations:**

- It is difficult to collect leaves during winter season.
- Not suitable for domestic purpose.
- Requires large quantity of leaves for briquetting process.

**VII - FUTURE DEVELOPMENT**

**(i)Fertilizer:**

It is a bio degradable product. Hence it may be used as natural fertilizer.

**(ii)Leaf Briquettes:**

Wood is the effective material which can be used as source to fire up the biomass gasifier. There is a possibility to make briquettes using the collected leaves which is biodegradable. If we use leaf briquette, there would be considerable decrease in the consumption of wood.

### **VIII - STUDY OF LEAF BRIQUETTE**

#### **(1) Reason for leaf briquette:**

The burning of the fallen leaves in loose form results in loss of fuel and widespread airpollution. However, briquetting the fallen leaves forestall the aforementioned problems. Fallen leaves briquettes have the following advantages over the loose ones, there is increase in the net calorificvalue per unit volume, the fuel is easy to transport and store, uniform in size and quality. Leaves covers a wide range of different species which show large variation incomposition and fuel characteristics. However, the percentage composition of the combustibleelements in the leaves whether in loose form or briquette form are very low compare to fossilfuels. Hence the low emissions of the oxides of the combustible elements. The emission of CO<sub>2</sub> formthe combustion of biomass (leaves and agricultural waste) is equivalent to the amount of CO<sub>2</sub> absorbed during itsgrowing cycle, so the net CO<sub>2</sub> released is approximately zero by mass.

#### **(2) Properties of leaf briquettes:**

The leaf briquettes posse's physical and thermal properties:

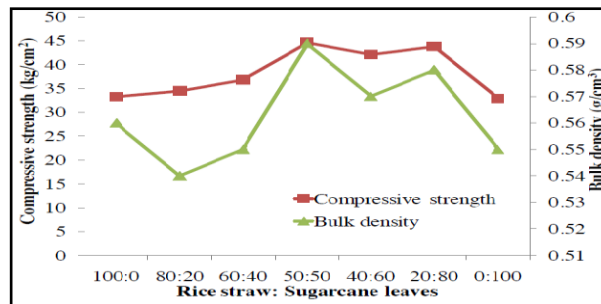
##### **(i) Physical property:**

##### **(a) Moisture content:**

Water content or moisture content is the quantity of water contained in a leaf briquette.

**(b) Bulk density:**

Bulk density is defined as the dry weight of leaf briquette per unit volume of leaf briquette.



**The compressive strength and bulk density of briquette fuels from rice straw and sugarcane leaves by mixing molasses [1].**

**(c) Compressive strength:**

Compressive strength is the capacity of a leaf briquette to withstand loads tending to reduce size, as opposed to tensile strength, which withstands loads tending to fracture.

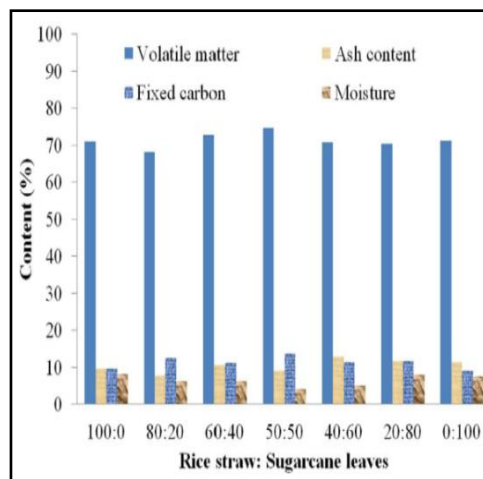
**(ii) Proximate analysis:**

**(a) Volatile matter:**

Volatile matter of a leaf briquette is the products that has a tendency to vaporize given the right conditions

**(b) Ash content:**

Ash content refers to the mineral content of a leaf briquette, and is determined by burning a given quantity of flour under prescribed conditions and measuring the residue.



Proximate analysis of the briquettes in weight percentage [1].

**(c) Fixed carbon:**

Fixed carbon is the solid combustible residue that remains after a leafbriquette particle is heated and the volatile matter is expelled. The fixed-carbon content of a coal is determined by subtracting the percentages of moisture, volatile matter, and ash from a briquette sample.

**(3) Ultimate Analysis:**

Ultimate analysis or elemental encompasses the quantitative determination of carbon, hydrogen, nitrogen, sulphur and oxygen within the leaf briquette.



Table 1. Ultimate Analysis and gross calorific value of dry briquetted samples

Treatments	Gross calorific value (MJ/kg)	N (%)	H (%)	C (%)	O (%)	S (%)
Rice straw: Sugarcane leaves (100:0)	16.33	0.34	5.6	38.7	36.4	0.02
Rice straw: Sugarcane leaves (80:20)	16.95	0.32	5.7	39.6	35.6	0.04
Rice straw: Sugarcane leaves (60:40)	17.01	0.27	5.8	41.6	35.2	0.03
Rice straw: Sugarcane leaves (50:50)	17.83	0.37	6.2	43.2	34.5	0.03
Rice straw: Sugarcane leaves (40:60)	16.99	0.41	5.6	42.5	35.5	0.04
Rice straw: Sugarcane leaves (20:80)	17.05	0.44	5.4	41.5	36.2	0.03
Rice straw: Sugarcane leaves (0:100)	16.43	0.36	5.6	38.6	35.9	0.02

#### (4) Gross Calorific Value:

The gross calorific value (also known higher heating value or gross energy) of a fuel is defined as the amount of heat released by a specified quantity (initially at 25°C) once it is combusted and the products have returned to a temperature of 25°C, which takes into account the latent heat of vaporization of water in the combustion products.

#### IX - CONCLUSION

None has considered fallen leaves as important one. Merely, leaves are collected swept and dumped through manual works. We thought of collecting fallen leaves which are available at tremendous level around us to be made as useful one through this project. Also we included blower with this setup which blows off dust particles. If the fabrication work of this project will be a successful one, it may get a commercial value and also it would be society oriented project. Eventually, we found it to be an auspicious scoping project for future.

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