VAN DE GRAAFF GENERATORS

THEIR CARE AND FEEDING

Presenter: Harvey Edwards - Principles & Practice

The frustration and hate of maintaining a VDG is fairly universal among Labies. Either you can seek help from a professional counsellor or by joining in this workshop you will gain lots of hints on how to service and maintain them with a minimum of hair pulling and swearing.

Sources:
Encyclopædia Britannica
The History of the MIT Department of Physics
AlphaLab, Inc.
IEC Aust.
University of Alabama, Department of Physics & Astronomy
Brookhaven National Laboratory's Tandem Van de Graaff Accelerator Facility

KNOW YOUR ENEMIES

- **Robert Jemison Van de Graaff**
  He invented this **** device.***
- **Water**
- **Dust**
- **Sharp edges**
- **Sunlight (UV)**

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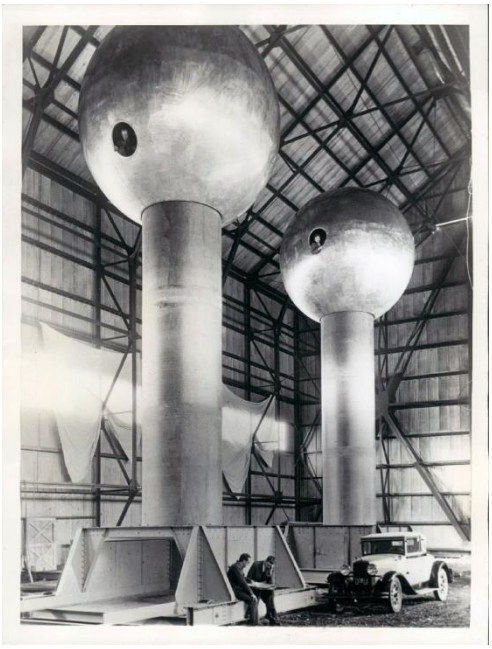
ROBERT JEMISON VAN DE GRAAFF

American Physicist and Inventor - Born Dec. 20, 1901, Tuscaloosa, Alabama.

Engineer with the Alabama Power Company, Van de Graaff went to Paris in 1924 to study lectures of Marie Curie turned his interests to atomic physics.

Constructed the first working model of the generator in 1929 (he was 28). His generator was created primarily to be a high voltage source for particle accelerators.



Robert J. Van de Graaff

Then Van de Graaff went to Round Hill, South Dartmouth, MA -a private research installation affiliated with MIT. There he built hulking, globe-topped generators capable of sending off electrical bolts and showers of sparks. The most massive of these, constructed in 1931 and dubbed the "Colossus of Volts," could generate up to 5 million volts of electricity and was large enough to host small laboratories in its domes.

Through the Second World War, the 1950s and sixties he continued his significant work in research into particle acceleration.

He died January 16, 1967 in Boston, Massachusetts. At the time of his death there were over 500 Van de Graaff particle accelerators in use in more than 30 countries.

HOW IT WORKS *In 25 words or less- The judges' decision will not be open to appeal.*

"Makes 'static electricity' by having two dissimilar materials in contact and then coming apart."
(The triboelectric effect).

The bottom pulley and the belt are these two materials.
For a full explanation: https://www.youtube.com/watch?v=EsZQS2GOMQE (From rimstar.org)

THE IEC MODELS:

Most VDGs in Australian schools have been made by Industrial Equipment & Control Pty. Ltd., who have been manufacturing them for two generations.
So by 2013;

- A few different cases are around with
- Many different styles of combs
- The belt material and construction has continuously evolved.
- Motor control changed from resistive to electronic control and then to low voltage speed rather than torque control.

Early units had a domed shaped base cast in aluminium.
Then box based models such as the 4142 & 4143 were produced in different colours.
Then a sloped front case with removable cover around the belt: 4137 & 4138
(And some Odd Balls eventuated along the way!)

Post the domed shaped base cast model, two versions have been available;
400kV, 280mm diameter dome (Approx. 120mm spark between balls.)
200kV, 200mm diameter dome (Approx. 75mm spark between balls.)

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BEATING THE ENEMIES:

WATER – or more precisely humidity. Check the lamp is working, That light bulb in the bottom is there to dry the column of any moisture – it's not just there to look good! (not fitted on removable cover models). Pre- dry with a hair dryer before use.

DUST – ANY dirt or dust particles on the dome, the discharge ball or the column will make the sparking deteriorate. Keep the system clean.

SHARP EDGES –Edges or protrusions cause the charge to leak away. Polish aluminium domes. Remove the dents.

SUNLIGHT (UV) - Do not store in front of an unshaded window – the belt is not UV stable! Cover it with two black garbage bags at least or just keep it in a cupboard in the dark.

MAINTENANCE PROCEDURES:

Check:

Plug and cord for safety, Earth Wire & Earth Terminal, Lamp working *(if fitted),*Motor working

DOME

Make sure the dome is clean – *no sticky tape residue!*
Aluminium domes:

Remove dents
Use metal polish to get a high polish on the dome.

- The same goes for discharge wands with aluminium spheres.

PULLEYS

Clean them with metho – remove all that gunk!
Check the bearings on top pulley.

SUPPORT COLUMN/ PLASTIC SUPPORT RAILS & CHARGING BELT COVER

This must be clean and dry. Use soapy water or a detergent that doesn't contain ammonia.eg Morning Fresh.

- there will be no problems with the plastic cracking or being damaged.

Then dry thoroughly.

COMBS

Angle Aluminium models – sharpen them, or even file series of teeth in the edge.
PCB Combs clean with a pencil rubber.
Foil on Rubber Combs – replace the foil

COMB CONNECTIONS
The upper comb must be connected to the upper dome. The lower comb must be connected to the grounded case.

COMB POSITIONING
The tips of the combs must not touch the moving belt, they does not need to touch the belt at all. Both combs must be on the same side of the belt. On the side so that the bottom comb is adjacent to where the belt leaves the pulley as it travels UP the tube. – Usually the front. The comb tips should be within 5mm (preferably closer) of the belt surface.

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THE BELT

Replacement belts for IEC models are available from IEC in Thornbury. Order the correct size: the large belt fits the 400kv models which have a 280mm dome. The 200kv models have a 200mm dome.

Belt testing: Get to know your own belt tension –when you've got the VDG working well measure it with a spring balance – in time you will know when it's time to order a new belt.
If a new belt slaps around, the column is way too short.

From BERNIE (Bernard Hodson-Managing Director I.E.C.)
"Stretch the belt over the back of an old chair or around a slab of wood or anything that will hold the belt stretched to about 25% longer than normal. Get some hot water and detergent and one of those scourers with the foam one side and that green hard stuff on the other side. Or a nail brush or anything with an aggressive bristle. Scrub the belt as hard as you like and flip it over to the other side and do it again with the hot water and detergent. Rinse it and dry it. It might feel just a bit 'sticky' when dry … this is good. If a bit 'sticky', dust it very slightly with talc (not enough to come off and make a mess)."
A GOOD WAY TO TEST IT:: If you hold the belt hanging down and place first finger and second finger either side of one thickness of the belt and pass your fingers briskly along the hanging belt while lightly allowing your fingers to brush along it, it might sound a bit crackly and the loosely hanging belt should want to attract to the back of your hand.

Fitting the belt is made easier by first tying a string to the old belt before pulling it out and using the string to thread the new belt up the column.

Motor

If motor is held in a steel 'U' shaped frame – it reduces the motor's torque by forming a "magnetic shunt". IEC will supply aluminium frame free of charge.

Bearings
Apply a drop of light oil onto the brass bushing where the shaft comes out of the motor and turn the motor over a few times manually, and re-apply another single tiny drop of oil. Then run the motor for a moment. Clean away any excess.

Motor Speed Control –does it work? What speed is it going? It should be fast.

TESTING

On split dome models remove the top half; On one piece dome models lift off the dome;
Bring your finger knuckle near generator top comb, small sparks will jump
– About 10mm long OK or 20mm - it is working very well.

USEFUL INFORMATION:

OUTPUT VOLTAGE
Since dielectric breakdown of air is approximately 33kV/cm an estimate of voltage can be made from the spark length achieved.

30mm	100kV	100mm	330kV
40mm	130kV	110mm	360kV
50mm	170kV	120mm	400kV
60mm	200kV	130mm	430kV
70mm	230kV	140mm	460kV
80mm	260kV	150mm	500kV
90mm	300kV	160mm	530kV

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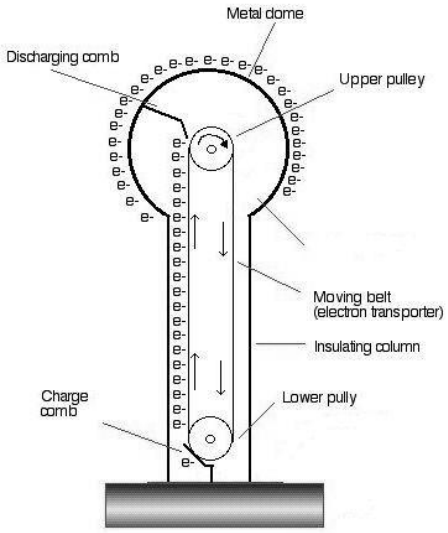
USING A VAN DE GRAAFF GENERATOR



It is quite natural to be afraid of a Van de Graaff generator (VDG), in fact it is probably healthy to be so inclined. It will keep you safe from the real dangers of electricity.
The Van de Graaff generator (VDG) is an extremely safe electrostatic device and this paper is written to help users become confident in its use whilst still giving it the respect all electricity deserves.

Confidence will come when you

- Know when a discharge will occur,
- Know how to minimise the sensation it creates
- Know how to control the discharge

First some important safety rules.

Though it is very, very hard to be injured by the generator there are a few points that should be remembered.

1. People with pacemakers should stay away from VDGs.

2. Getting a spark in the eye could cause a serious injury. Don't ever point at a person's face while using a VDG even if you are discharged - they may not be!

3. Keep all electronic equipment well away from the VDG. Electronic equipment such as watches, calculators, computers and mobile phones can be very sensitive to static electricity and the VDG generate 200,000 volts or more.

4. Be aware of the dangers of using a Leyden Jar with a VDG. The Leyden Jar acts as a capacitor and because it stores the electrostatic charge it has the potential to produce a much higher current discharge.

5. Remember that the small sparks of a VDG might be slightly painful, but danger is greatest from the surprise they cause if they happen unexpectedly

Discharging by 'LEADING' with the EARTH

Remember the discharge will always take the easiest path - that is most often the shortest path. So prior to handling the VDG or its fittings ensure you **'LEAD' with the EARTH** not yourself. That means the metal discharging earthing point you use, should always be closer to any possible charged object than the hand holding it.

Always ensure the discharging sphere (the small sphere attached to a handle) is connected with the correct earthing lead to EARTH connector on the base of the unit. Then always ensure the discharging sphere is closer to the VDG than any other part of your body.

FIRST contact WITH THE LEAST sensitive

The back of your hand is a very insensitive part of your body - so it will take a light spark from a VDG with a lot less feeling than the tip of your finger. Use this knowledge to minimise any shock from the first time you come into contact with the equipment.

So when you go to switch off the VDG, touch the back of your hand on the switch panel first before rolling your hand over to switch it off with your finger.

Similarly when picking up the discharging sphere to discharge items, touch the handle of the discharging sphere with the back of your hand first in case you are charged!, before grabbing hold of the handle properly.

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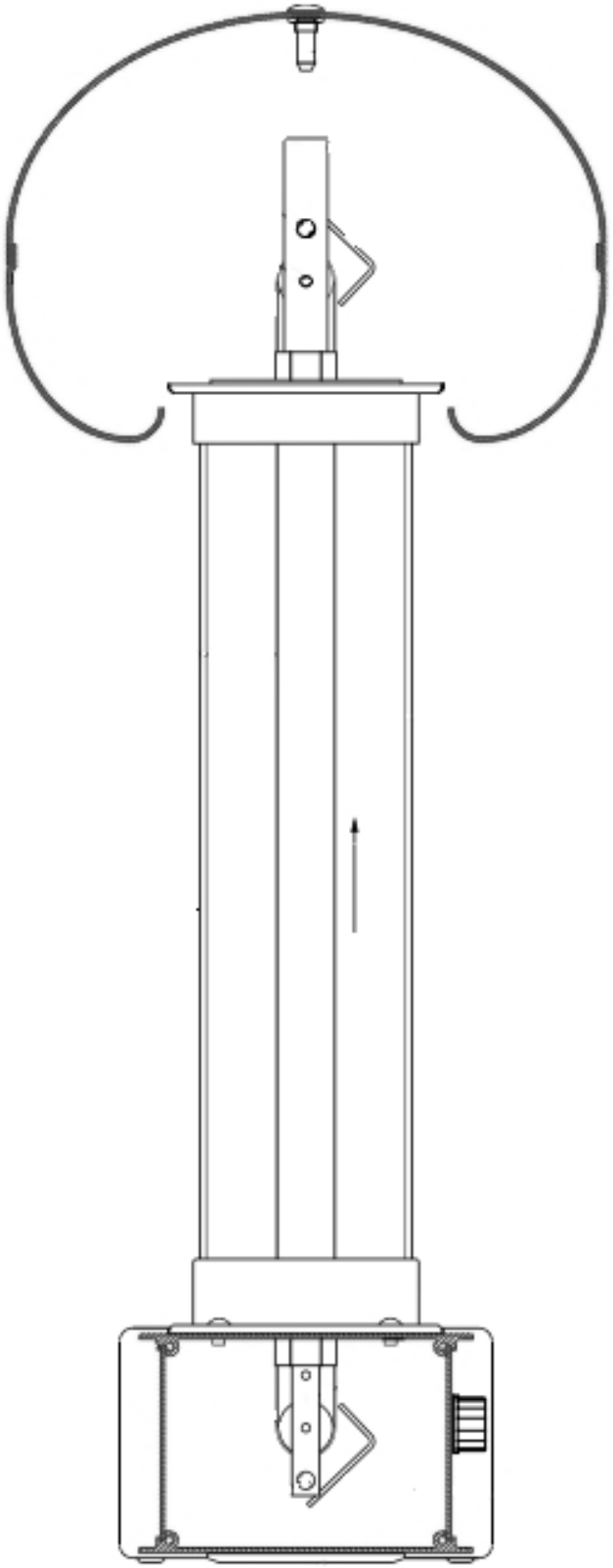
FOR YOUR NOTES



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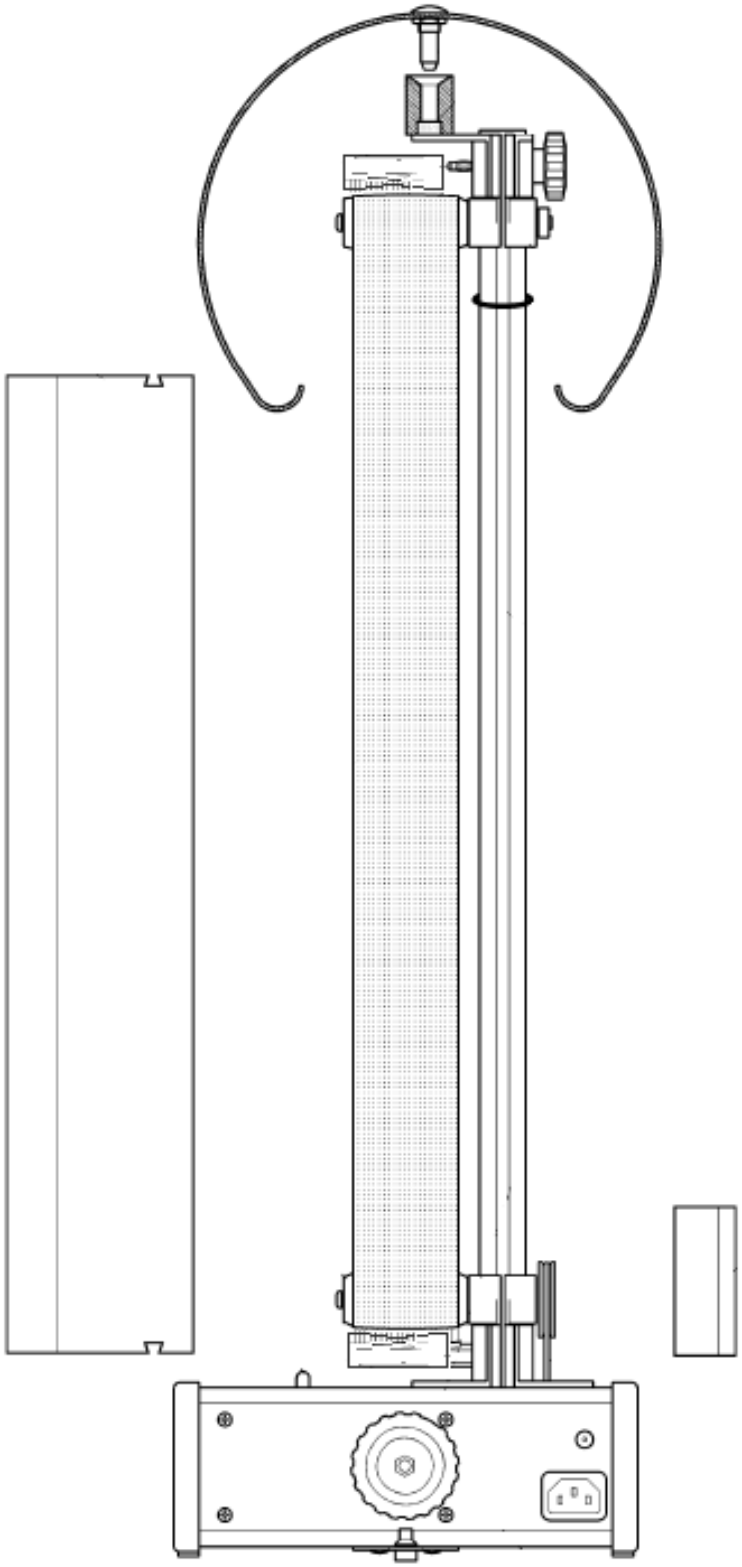

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