Van De Graaff Generator

Hand Operated

EM4152-001

Description:

The “IEC” 180mm diameter Van De Graaff is a modern, compact and robust instrument that is specially designed with all parts fully exposed for use in the classroom.

This hand driven model does not require electrical power.

Features:

- Compact design.
- Easy to use and reliable performance.
- Strong construction.
- All parts in full view.
- Stainless steel dome & ball.
- Easy removal of dome.
- Adjustable spark gap.

Main Ball Diameter: 180mm	Height: 630mm	Weight: 3.0kg

Specifications:

Output:
EM4152-001 150 kV under good conditions. 5 to 6cm spark gap between balls.

Discharge Ball:
80mm.D. with insulated handle and earth terminal connection.

Charging Belt:
55mm wide silicone rubber. PA4137-010S

Drive Drive:
Belt driven from a hand wheel with vee groove. PA4152-012S

Assembly Procedure: No Tools Required

The Van De Graaff is supplied in 5x parts and assembly is very easy, The parts are:

- Base with motor drive (or hand driven plastic wheel), belt pulley, 'comb' under the belt pulley, discharge ball support device and 2x earth terminals.
- Upper plastic socket, with metal pulley, belt and 'comb' fitted in a simple 'U' shape metal frame. 2x earthing cables with banana plugs and alligator clip.
- Clear plastic insulation tube.
- Upper main dome, 180mm diameter with internal support pin.
- Discharge ball, 80mm diameter, with handle and earth terminal.

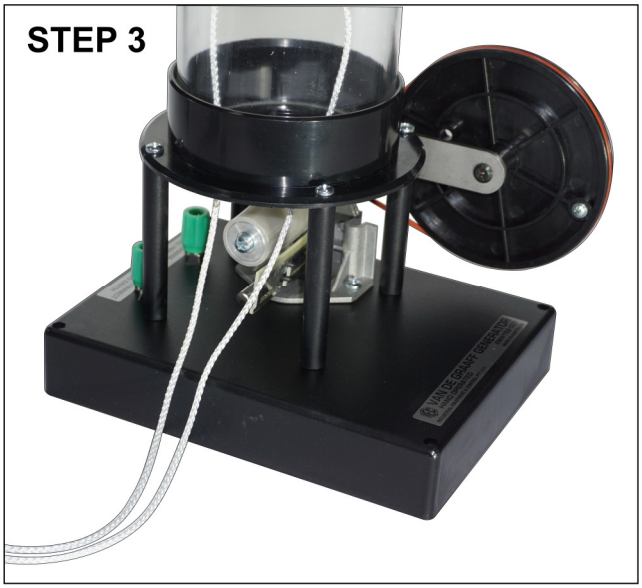
Remove parts from all the boxes and identify each part as listed above.

The following assembly instructions can be used for all models of "IEC" Van De Graaff, whether manually or electrically driven.

The Parts

STEP 1

STEP 3

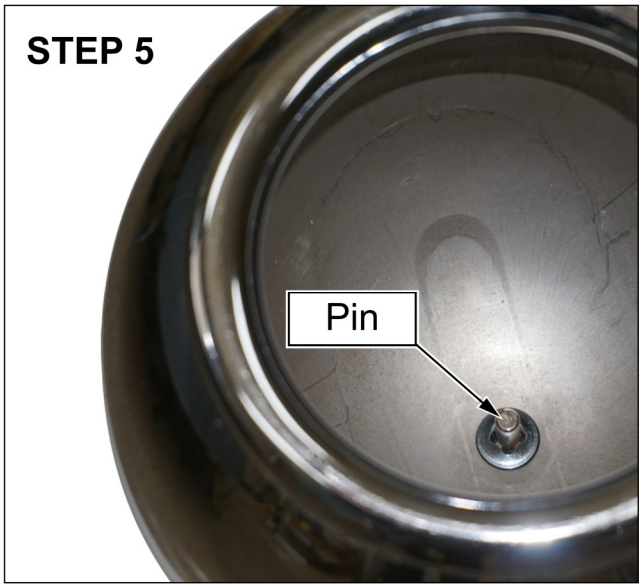


STEP2

1) Take the large clear plastic tube and press it firmly into the socket provided on the base.

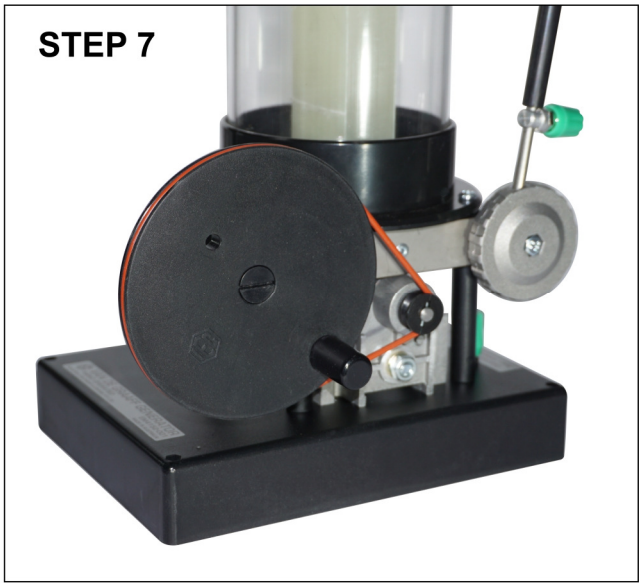
2) Take the upper plastic socket with frame assembly with belt and string. Place the belt with the attached string down the tube and engage the socket to the top of the large plastic tube with the upper and lower pulleys aligned. Allow the string to hang loosely near the lower pulley.

3) Using the string, stretch the belt downwards and, with the fingers inside the belt, slide the belt over the lower plastic pulley. Untie or cut the string to remove it. If necessary, twist the tube or socket a little to make the upper and lower pulleys align with each other so the belt is straight.



4) Reach under the lower pulley and adjust the lower comb so the edge with the small bars is almost touching the belt surface. Similarly, adjust the upper comb so the small bars are almost touching the belt surface.

5) Take the large upper dome and note the metal pin inside. This pin must engage into the hole in the blue socket mounted on the upper frame. A magnet in the bottom of the socket will pull the pin to hold the dome securely into place. Invert the dome over the blue socket and feel the pin



6) Take the discharge ball and screw it to the end of the discharge ball handle. There are 2x earth terminals mounted to the base. Take a green cable and connect the terminal on the discharge ball handle to socket on the base marked “discharge ball handle”. The second cable with alligator clip will be used to connect the other earth terminal to a large earthed mass (see below).

7) Insert the bottom of the handle in the hole of the discharge ball support device and, by firmly moving the discharge ball handle, adjust the angle for the desired gap between the dome and the ball.

Before Operating any Van De Graaff Generator :

The new manually or electrically driven IEC Van De Graaff generators have no connection between the mains power outlet and the metalware of the Van De Graaff.

This means that any charge created and sparked between the balls passes from the dome to the base but cannot pass to the mains earth system. This design is to prevent high discharge voltages and currents from passing into the mains earthing system and causing major trouble and destruction of computers and other equipment connected to mains in the same building.

Without earthing the base metalware, the discharges from the dome to the base will cause high voltage pulses on the metalware of the machine that will cause uncomfortable discharges to the users. To avoid this, and to provide a circuit that can absorb the discharged energy, the metalware of the base of the Van De Graaff MUST be connected to a large mass that is earthed. This large earthed mass can be perhaps:

- Any metallic part of the building's construction, a girder, beam or a cabinet.
- A large metal object like a filing cabinet or a metal window frame.
- A wire say 1.5 mm diameter can be run through a window to an external garden tap or to a spike driven well into the soil.
- Any metallic part of the water plumbing system of the building, a metal sink, pipe or tap.
  DO NOT CONNECT THE EARTH CABLES TO GAS FITTINGS OR GAS PIPES.
  A SPARK UNDER THESE CIRCUMSTANCES CAN BE DANGEROUS

Principle of Operation:

The rubber belt is driven by the plastic pulley and a charge is induced on the surface of the belt as the rubber belt leaves contact with the plastic pulley. Negative electrons jump from the belt to the earthed comb to cause the belt surface to become positive potential.

The belt carries the charge to the dome. The inside surface of the belt touches the metal pulley to become the same potential as the dome and the positive charge across the belt thickness is removed from the belt by the sharp points of the upper 'comb'. This charge from the belt adds to the dome's existing charge so that the charge rises over time.

The outer surface of the dome acquires an increasing positive charge in respect to earth. This 'charge pumping' effect is cumulative until a voltage on the large dome is sufficient to cause a spark discharge between the dome and the discharge ball.

Operating Conditions:

The best results will be obtained in a dust-free atmosphere of low humidity and with clean and smooth dome, discharge ball and insulating tube. The machine should be placed at least 1 metre from walls, light fittings, plumbing, etc. particularly if these objects present sharp corners or edges. The discharge ball should be earthed by connecting to the Earth terminal on the base of the unit using the flexible wire supplied and the unit itself can, if desired, be earthed to a large mass by using the other terminal (see previous explanations).

During prolonged operation, the discharge ball rod (with or without the earth cable attached) may be 'parked' by inserting into the hole in the discharge ball support device mounted on the base. To alter the spark gap, adjust the 'parking' angle of the discharge ball.

The discharge ball's insulated rod may be held in the hand, but to avoid sensations to the hand, the earthing cable should be attached to one of the earthing terminals on the base.

General Precautions All Models:

- Approach the operating Van De Graaff machine with caution at all times. A spark discharge, although harmless, can be a little uncomfortable.
- Never come close to a Van De Graaff if you are wearing any electronic equipment similar to say a 'pacemaker' heart instrument and so on.
- If the discharge ball is closer to the dome than the user, sparking will jump to the ball first, therefore, try to stand behind the discharge ball and do not approach too close to the charged dome. Note that if the earthed discharge ball is positioned so it is touching the dome, the dome will be held at earth potential and will be safe to touch.
- After switching off the machine, always earth the large dome to discharge it by touching it to the earthed discharge ball before touching it with the hand.
- Remember that just being in proximity to a Van De Graaff will make your body collect a static charge, especially if on carpet or wearing insulating soled shoes. As you touch some neutral object, a small discharge may often be felt as you discharge.
- Handle the large dome gently since dents are difficult to remove and, if seriously dinted or scratched, operating efficiency can be reduced.
- Always hold the discharge ball support rod by the insulated handle provided. Always have the earth cable attached.
- Since sunlight causes deterioration of most materials, the unit should always be stored in a well shaded place when not in use. Do not store in front of an unshaded window.

How to Run the Machine:

Attach the green earth cable between the terminal on the discharge ball handle and the earth terminal on the base. Connect the other earth terminal to an earthed mass (see previous explanation). Insert the discharge ball handle into the support device and set the spark gap to about 5 cm.

Maintenance and Cleaning:

Dirt and moisture both cause poor performance. If very dirty, the charging belt may be wiped with a cloth moistened with alcohol (methylated spirits). Be sure it is dry before using and, a very small amount of talc can be rubbed into the belt inner surface to help charging.

The plastic insulation tube may be cleaned by wiping with a soft cloth or, if necessary, with warm water & detergent. Never use solvents of any type on the tube or the plastic base.

Both pulleys must be free from any dirt or rubber build-up. They can be wiped firmly with a cloth moistened with alcohol. Allow all components to dry before evaluating the performance of the unit.

The above procedure is a major cleaning operation and should be performed only when most adverse conditions demand it. A normal cleaning routine is to simply wipe the large dome, the small discharge ball and the surface of the plastic tube with a soft lint-free cloth. Note that ANY dirt or dust particles on either the dome or the discharge ball will make the sparking deteriorate. Keep the system clean. It is a good idea to cover the instrument when in storage.

Fitting and Removing the Main Dome:

The top dome connects to the upper pulley bracket by a pin that slides into a hole in the blue plastic socket. Place the dome over the pulley bracket assembly and move it so the pin is close to aligned with the socket and, when the pin has entered into socket, lower the dome until the magnet is felt holding the dome firmly in place.

To remove the dome, with both hands at the same time, bump the dome gently upwards and lift from its socket.

The Charging Belt:

The silicone rubber belt has a high contact potential with the material of the lower pulley. If a belt loses the ability to charge, application of a very small amount of talc into the surface of the rubber will improve insulation and slip and often improves the performance. Wipe off all excess talc because too much will make a mess.

The moulded IEC silicone rubber belts have now superseded the old latex belts that have been used for many years..

Removal and Replacement of the Charging Belt:

Lift the upper dome from its socket and twist the upper and lower 'combs' away from the belt Slide the belt off the lower pulley so that it hangs loose in the plastic tube, then pull the metal 'U' frame from the upper plastic socket with the belt dangling.

If necessary, loosen the knurled screw holding the 'comb' support rod a few turns and, using both hands, spread the legs of the 'U' frame a little to remove the pulley shaft from the 2x holes in the frame. Slide a new belt on the pulley and allow it to dangle down the tube to be caught at the bottom and slid on the bottom pulley. Then refit the top pulley shaft to the holes in the 'U' frame. Re-tighten the small knurled screw. Squeeze the 2x legs together slightly to hold the top pully firmly and slide them into the plastic collar.

At both the top and bottom pulleys, adjust the comb to be almost touching the belt.

Attachments:

IEC manufactures a set of 7 different useful attachments to fit to the top of the main dome. This set is catalogue number EM4144-001. Details can be obtained from the IEC website: www.iecpl.com.au

Useful Observations:

- Discharge rates, colours and intensities at various spark gaps.
- Pull of attraction between balls of opposite polarity.
- In the dark, see the corona discharge from tip of discharge ball support rod.
- If a person stands on an insulating sheet of plastic and places his/her hands on the Van De Graaff dome, as the generator begins to charge, the charge on the person's body will make long dry hair stand up from their head. This is a popular and harmless trick done with Van De Graaff machines.
- Check polarity and measure actual current flow with 0-25 micro-amp meter. This current measurement is a good check on the performance of the unit. A unit that will perform well and charge at a high rate and provide rapid large sparks will have a short circuit current of about 4 microamps or higher. If the current is high but the performance is poor, look for dirt or dust on the dome or discharge ball and look for unwanted discharges to sharp corners or points of nearby items. If the current is poor, it is usually that the belt requires replacement or the belt or pulleys are dirty. Clean with a soft cloth dampened with methylated spirits.
- Retention of charge after machine is switched off.
- Difference between discharge to a ball and discharge to a point.
- After switching off, note charge on belt surface. Touch with the finger.
- In a darkened room, see leakage paths, discharges to dust in the air, brush discharge from the 'combs', different shapes of sparks, effect of bringing different objects close to the dome when it is at a high potential.
- Note the behavior of a scrap of paper dropped between the balls.
- For electrically driven machines, reduce the power (torque) of the motor and observe the belt slow down as the charge on the dome increases. Work is done to transport charge on the belt from a place of low potential (the lower housing) to a place of high potential (the upper dome).

Designed and Manufactured in Australia