

Van de Graaff – Troubleshooting guide

General principles

When working with the rollers and the rubber band: Use disposable plastic gloves in order not to apply finger grease to these parts.

All the initial inspections can be performed with the generator shorted from the dome to the base.

Visible inspection

Is the rubber band old and cracked or very loose?

– Replace it.

Is the rubber band dirty?

– Clean it like this: Remove it. Wash with water and soap, and cleanse thoroughly with water. Cleanse with isopropyl alcohol or benzine. Apply a small amount of talcum powder with a dry cloth. Shake or blow away the surplus. Put the generator together again.

Are the columns dirty?

– The columns can be cleaned with a damp, clean cloth or chamois. Stubborn stains may be removed with isopropyl alcohol. Use alcohol sparingly, the material may be damaged.

Is the dome dirty?

– Wipe it with a cloth. It is important to remove dust and hair – it doesn't need to be shining.

Are the rollers dirty?

– They can be cleaned with a damp, clean cloth or chamois. Stubborn stains may be removed with benzine. Take care not to apply benzine to the columns.

Does the gauze touch the belt at the lower roller?

– It must **NOT** touch the belt! A gap of 1 to 2 mm is fine. Has the gauze been touching the belt: Remove the belt and clean it thoroughly as described above. (Fine metal particles are probably sticking to the belt which makes a conducting path.)

Mechanical inspection

First check: Is the lamp lit when the switch is turned on?

– If not, check the fuse and replace it if needed.

Take the drive belt off. Is the motor spinning when turned on?

– If not, the motor must be replaced.

Is the drive belt worn or cracked?

– Replace it.

With the drive belt back in place: Does the lower roller rotate when the motor does?

– If not, remove the drive belt again and turn the pulley at the lower axle with your fingers. If the friction is too high, the bearings may need to be oiled a little. Take care not to apply any oil to the roller or the band.

Electrical inspection

Stop the motor and short the dome to the base to ensure that there is NO charge on the dome.

Insert a micro-ammeter (multimeter) in the circuit:

Ammeter "+" (plus / uA) connected to the dome, ammeter "-" (common / gnd.) connected to the base.

Turn on the motor again.

Does the ammeter display a **negative** current in the order of 5 micro amperes or more?

– If not: The belt is not charging correctly.

– If it does: The belt is charging correctly. Any problems must be with charge leaking. Clean the generator as described previously.

Does the ammeter display a **positive** current?

– This means that the belt needs a little talcum powder.

Van de Graaff – Questions and answers

This is an excerpt from our mailbox concerning the van de Graaff generator. It has been slightly edited to clarify the issues.

Q:

We have a customer call saying that one of your van de Graaff generators is giving off electric shocks from the base when turning off using the mains switch. Would it need to come back to you please or is there something that can be done by the customer?

A:

A person standing close to the dome will be electrically charged (or rather polarized) by electrostatic induction. If you then touch the grounded base of the generator, your fingertip discharges, resulting in a small electric shock.

If you keep yourself grounded at all times by holding the tip of a wire connected to the base, this will not happen.

Even so, you CAN get a shock from the base when a spark hits it. It will be harmless and felt much less than if a spark hits you directly - which isn't dangerous either, albeit unpleasant.

The explanation is that in a very short time interval, the spark represents an impressively large current. The ground wire in the power cord has too much inductance to short this fast charge pulse to ground immediately. This means that the electric potential of the base will jump, and if someone is touching it, some of the current will probably run through the person instead of the ground wire.

It is worth keeping in mind, that this is a transient phenomenon - it only happens when a spark hits the base. The average current is limited to the charging current of the generator which is only a few microamperes.

Naturally, the same sensation of a shock can be a warning of fatal electrical errors in mains connected equipment. In these cases, the source is the mains voltage which can provide many amperes of current - enough to instantly kill or severely injure a person.

The Frederiksen van de Graaff generator is provided with a grounded power cord. When used with a properly grounded mains outlet, any (extremely unlikely) short circuits from mains voltage to the chassis will only cause the fuse to blow. End of story, nobody gets hurt.

Q:

A customer has asked for our help with replacing the lower gauze on his Van de Graaff. We have had a look at one here, tried taking it apart to do this, but found it difficult. Do you have any tips on how to do this that you could pass on to me please? Also we noticed that the Allen Key enclosed which I always thought was for undoing the bottom roller no longer fits as the fitting in the roller is larger now so a bigger Allen Key is needed. Were you aware of this?

A:

First of all, the lower gauze should never need to be replaced unless it has been mistreated badly. It is NOT an easy process to replace it.

Customers sometimes neglect the manual and try to "adjust" the gauze in order to make it touch the belt (which it should absolutely not do). This often results in something looking like the hedges after a steeple chase.

Danish customers are advised to ship the generator back to us if this happens - but it is of course not so easy for foreign customers (and should always go through the local distributor).

The 1.5 mm Allen key is for fitting the security adapter on the 4 mm ground connector. In Denmark, "bare" banana plugs are not allowed in school labs, so all the equipment we produce must accommodate the shrouded safety connectors. The adapter plus the key are provided as a standard - your customers probably don't need it, but it won't hurt if they mount the adapter as it also accommodates the standard plug.

For removing the lower roller, a 2.5 mm key is needed.

Q:

We have had one of your Van de Graaff generators returned to us exhibiting some strange behaviour: the dome is discharging along the belt to the base. I've attached a video demonstration.

We've tried cleaning and drying the whole apparatus but this has not solved the problem. Have you ever seen this before, and if so, can you suggest what we might do to fix it?

A:

This is neither uncommon, nor a fault. From the video, I would judge the generator to be in a very good condition.

It seems that the fundamental principles behind the generator remain a mystery to many. Please forward the explanation below to your customer - you're welcome to edit it to fit your purpose.

The van de Graaff generator is essentially a constant current generator. This means that a constant amount of charge is offloaded on the dome pr. second. This, in turn, means that the voltage grows linearly over time - until some mechanism takes over to reduce the charge.

"Some mechanism" may be a corona discharge - which usually is the case when pointed objects are present on the dome or in the surrounding - or it may be a spark as in this case.

When we test our van de Graaff generators, we always have the conductor sphere (3705.00) to form the other electrode of the spark gap. If there is no other object in the vicinity, the base of the generator will be the closest point for the sparks to end. The tendency to run along the belt could be caused by the small charge carried with the belt - I guess that this will be enough asymmetry to make the belt the preferred route for the sparks.

When used with the conductor sphere, sparks with a length of 80 mm or more indicates a fully functional generator.

Once in a while, unfortunately, customers don't read the manual and mistakenly "adjust" the fine wire mesh below the lower roller to make it touch the belt. This means that tiny metal particles are deposited

on the belt. In this case (if the generator works at all) the sparks will also run along the belt, but they will never build up the size seen on the video. And the voltage will remain too low.

Q:

Just letting you know that I applied some talcum powder to the lower roller and let it run through the machine.

Now it produces lots of sparks!

So all is working very well now.

- > We recently received one of your van de Graaff generators, 3700.60.
- > We are having some difficulty with reliable operation.
- >
- > I've attached a photo of the bottom mesh, showing that it is uneven.
- > Is this a problem for correct operation?
- > The gap between the band and mesh is several 2-3 mm.
- >
- > The device was working quite well before this week, but it has performed poor this week.
- > Yesterday, there was essentially no charge accumulating, despite dry, sunny weather.
- > This morning the performance was better, with 5-cm sparks being produced every ~20-30 seconds.
- > We have cleaned the band, but the generator now produces only one good spark and then doesn't work.

A:

What I would suggest was exactly the solution you found yourself:

1st - Ordinary cleaning. Beware not to damage the mesh below the lower roller.

2nd - Apply a small amount of talcum powder on the inner surface of the belt or better directly to the lower roller. Too much powder is not an advantage.

Q:

A customer of mine has your Van de Graaff generator on which the upper drive belt pulley is squeaking and it seems like it is dragging. Thus, he asks what type of lubrication you would recommend to help the pulley to stop squeaking? I was going to suggest silicone oil or sewing machine oil but I wanted to ask you if you had any recommendations.

A:

A very small amount of grease should be better than using oil. It will not drip so easily. On the other hand: oil will by itself spread into the bearing.

It is of course very important that no lubricant finds its way to either the outer surface of the roller or to the belt (especially the inner side).