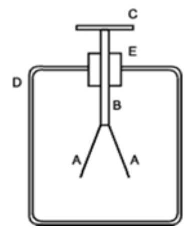
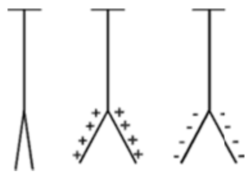
Electroscope Demonstration

From http://www.roymech.co.uk/Related/Electrics/electrostatics.html

An electroscope is a device to determine or measure the presence of electrostatic charges. The device's operation is simply based on the Coulomb Force Law. This is a relatively crude instrument used only for education. Modern instruments, based on vacuum tubes or solid state technology can be used to measure extremely small charge levels.



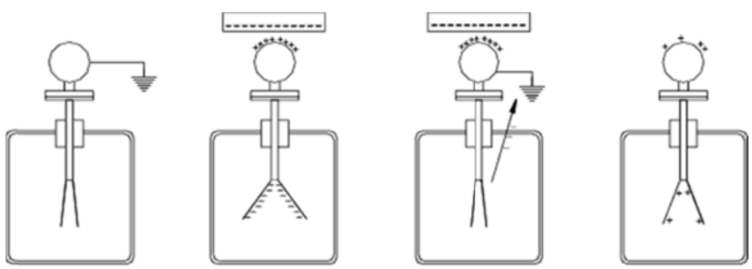
Two gold leafs (A) hang from a metal rod (B) within a metal container D. The top of the rod supports a conducting disc C (or a sphere). The rod is supported in a highly insulating stopper (E).



If the gold leaves become charged, because each leaf is equally charged , the leaves repel each other.

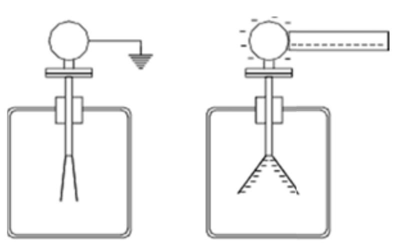
The metal case isolates the gold leaves from external influences. The case includes a window to enable the leaves to be viewed.

The electroscope is very useful for illustrating two methods of transferring electrical charges: induction and conduction. The two figures below show the principles in action.



Electrostatic Induction

First the electroscope is earthed. A negatively charged object is moved close to the electroscope system causing a separation of charges the -positive charges moving towards the charged objects and negative charges moving to the gold leaves causing them to separate. If the electroscope is earthed without moving the charged objects then the negatively charges flow to earth. If the earth and the charged objects are removed the positive charges distribute over the electroscope system...

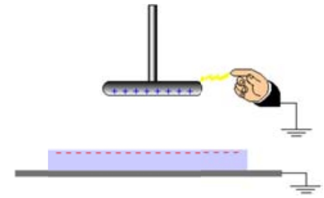


Electrostatic conduction

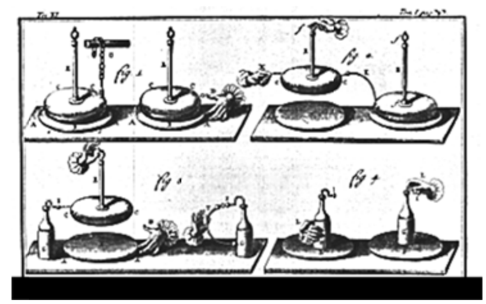
Physical contact by a charged object causes a flow of charge into the electroscope. This is used to identify that the object is charged.

Electrophorus

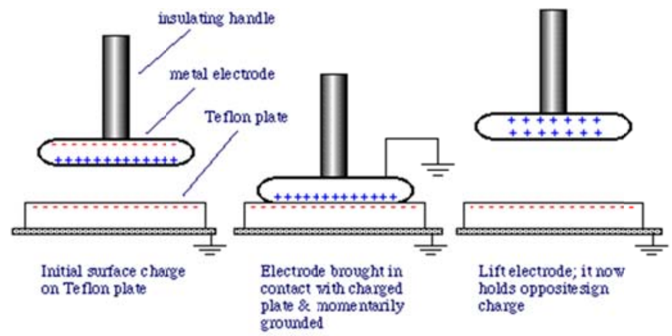
From: http://www.ece.rochester.edu/~jones/demos/electrophorus.html



Johannes Wilcke invented and then Alessandro Volta perfected the electrophorus well over two hundred years ago. This device was quickly adopted by scientists around the world because it filled the need for a reliable and easy-to-use source of charge and voltage for experimental researches in electrostatics [Dibner, 1957]. Many old natural philosophy texts contain lithographs of the electrophorus.



A hand-held electrophorus can produce significant amounts of charge conveniently and repeatedly. It is operated by first frictionally charging a flat insulating plate called a "cake". In Volta's day, the cake was made of shellac/resin mixtures or a carnauba wax film deposited on glass. Nowadays, excellent substitutes are available. Teflon^{TM}, though a bit expensive, is a good choice because it is an excellent insulator, charges readily, and is easy to clean and maintain. The electrophorus is ideal for generating energetic capacitive sparks required for vapor ignition demonstrations.



The basic operational steps for the electrophorus are depicted in the sequence of diagrams below. Note that the electrode, though making intimate contact with the tribocharged plate, actually charges by induction. No charge is removed from the charged cake and, in principle, the electrode can be charged any number of time by repeating the steps depicted. Click here to view a neat animation of the electrophorus charging process. Ainslie describes interesting experiments with an electrophorus that was charged in the Springtime and then its charge monitored throughout the summer [Ainslie, 1982]. The apparent disappearance of the charge during humid weather and its reappearance in the Fall must be attributed to changes in the humidity.

Polarization

From: http://www.physics.sjsu.edu/becker/physics51/elec_charge.htm

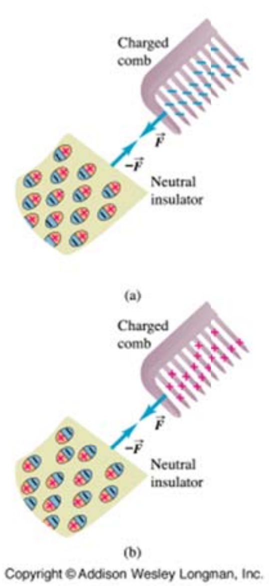


Fig. 21.8 A charged comb attracts a piece of paper.

Although the charges (on the electrons) are tightly bound to the atoms in an insulator they are free to move slightly within the atom. This is called **polarization**. If a plastic comb is rubbed on fur (or your dry hair) electrons will be rubbed off the hair onto the plastic comb. The plastic comb becomes charged negatively. If the comb is brought close to a neutral insulator, like a piece of dry paper, it will repel the negatively charged electrons in the atoms causing them to moving away slightly, leaving the protons without an electron closer to the comb. Since opposite charges attract and the positive charges are closer to the comb than the negative charges, the piece of paper is attracted to the comb. This effect is used to remove soot and ashes from smoke going up industrial chimneys. The inventor became rich as a result of his patent!

Part (b) of the diagram shows the same result (attraction of the paper) even if we had a positively charged comb.

Electroscope Lab

Procedure:

1. Rub the blue strip 40 times with the wool
2. Place it near the conducting sphere of the electroscope. Do not touch the sphere. What happens?
3. Pull the blue strip away from the conducing sphere of the electroscope. What happens now?
4. Now touch the conducting sphere of the electroscope with the blue strip. What happens?
5. Remove the strip from the conducting sphere, what happens?
6. Explain your observations above.
7. Touch the conducting sphere of the electroscope with your hand to ground out the leaves.
8. Repeat steps 1-7 with the long clear strip.
9. Rub the blue rod 40 times with the wool
10. Touch it to the conducting sphere.
11. Do not touch the conducting sphere with your hand
12. Rub the long clear rod with the wool 40 times.
13. Touch the electroscope ball with the charged clear strip. What happens? Why?
14. Ground out the electroscope with your hand (Touch the conducting sphere)
15. Charge up a blown up balloon by rubbing it in your hair.
16. Touch the balloon to the conducting sphere
17. Experiment with the blue and clear strips and the electroscope to determine if the balloon is positive or negative.

18. If available, verify your answer with the negative pith ball.

Electrophorus Lab

1. Ground out the electrophorus and the electroscope with your hand.
2. Place the electrophorus near the electroscope and notice the foil leaves do not move.
3. Place the metal electrophorus on the charged plate.
4. Touch the electrophorus with your finger
5. Remove your finger from the electrophorus
6. Now pick up the electrophorus and place it near the conducting sphere of the electroscope. What happens?

7. If available, determine the type of charge on the electrophorus with the negative pith ball.

Polarity of Paper

1. Tare up a piece of paper into small pieces.
2. Ground out the paper and the blue strip.
3. Charge the blue strip with the wool 40 times
4. Place the blue rod near the paper, do not touch the paper. What happens? Why?
5. Ground out the paper and the long clear strip.
6. Rub the long clear strip with the wool 40 times
7. Place the clear strip near the paper, do not touch the paper. What happens? Why?
8. Explain polarity.