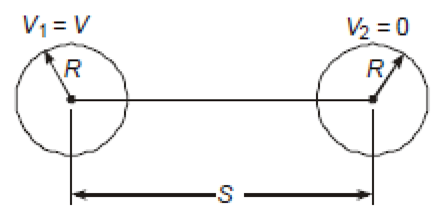
Electrostatics –field of sphere gap

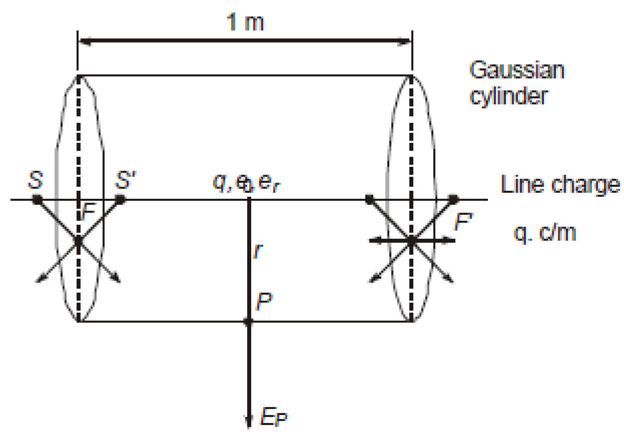
- A sphere-sphere gap is used in h.v. laboratories for measurement of extra high voltages and for
- calibrating other measuring apparatus. If the gap spacing is less than the sphere radius, the
- field is quite well determined and the sphere-gap breaks down consistently at the same voltage
- with a dispersion not exceeding ±3%. This is the accuracy of such a measuring gap, if other
- precautions are taken suitably such as no collection of dust or proximity of other grounded
- objects close by. The sphere-gap problem also illustrates the method of successive images used
- in electrostatics.



$V_1 = V$
$V_2 = 0$
R
R
S

Field of line charges

- line charge of q coulomb/metre and we will calculate the electric field
- strength, potential, etc., in the vicinity of the conductor. First, enclose the line charge by a
- Gaussian cylinder, a cylinder of radius r and length 1 metre. On the flat surfaces the field will
- not have an outward normal component since for an element of charge dq located at S, there
- can be found a corresponding charge located at S' whose fields (force exerted on a positive test
- charge) on the flat surface F will yield only a radial component. The components parallel to the
- line charge will cancel each other out.



1 m
Gaussian
cylinder
S
S'
q, e₀, e_r
Line charge
F
F'
q. c/m
r
P
EP

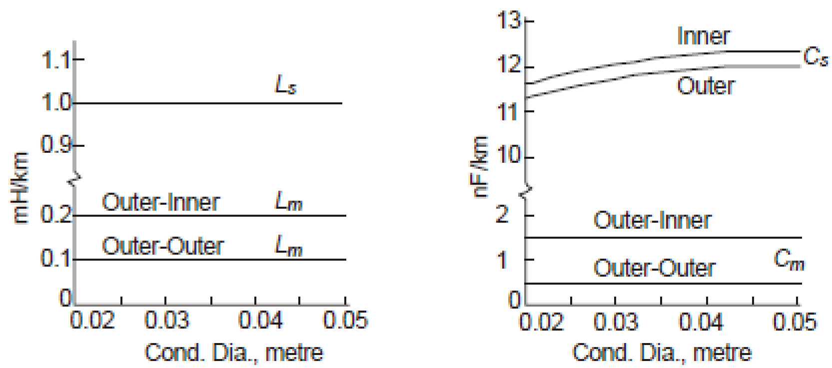
Properties Charge

- The properties of electric field of almost all electrode geometries will ultimately depend on that
- of a point charge. The laws governing the behaviour of this field will form the basis for extending
- them to other geometries. Consider Figure 4.1 which shows the source point $S1$ where a point
- charge + Q coulombs is located. A second point charge q coulomb is located at $S2$ at a distance
- r metre from $S1$. From Coulomb's Law, the force acting on either charge is

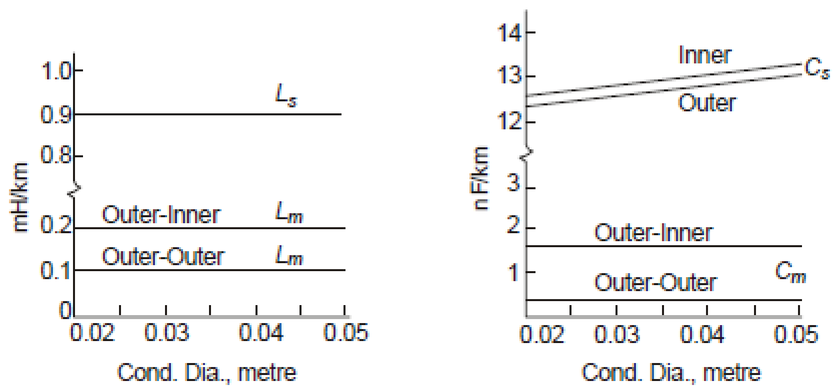
potential relations for multi-conductors

- charge-potential relations of a transm ission line with *n* conductors on a tower. The effect of a ground plane considered as an equipotential surface gave rise to Maxwell's Potential coefficients and the general equations

Surface voltage gradient on conductors



750-kV Horizontal
H = 20 m, S = 15 m
N = 4, B = 0.4572 m



1200 kV, Horizontal
H = 20 m, S = 24 m
N = 8, R = 0.6 m

Distribution of voltage gradient on sub conductor of bundle

- The method described before for calculating voltage gradients for a twin-bundle conductor, $N = 2$, can now be extended for bundles with more than 2 sub-conductors. A general formula will be obtained under the assumption that the surface voltage gradients are only due to the charges of the N sub-conductors of the bundle, ignoring the charges of other phases or poles and those on the image conductors.

Distribution of voltage gradient on sub conductor of bundle-examples

- The cosine law has been verified to hold for bundled conductors with up to 8 sub-conductors. Only the guiding principles will be indicated here through an example of a 2-conductor bundle and a general outline for $N \geq 3$ will be given which can be incorporated in a digital-computer programme.
- detailed view of a 2-conductor bundle where the charges q on the two sub-conductors are assumed to be concentrated at the conductor centres.