traverse the section of this current in one second,—these units being such that any two of them, placed at unit of distance, repel each other with unit of force.

We may suppose either that E units of positive electricity move in the positive direction through the wire, or that E units of negative electricity move in the negative direction, or, thirdly, that $\frac{1}{2}E$ units of positive electricity move in the positive direction, while $\frac{1}{2}E$ units of negative electricity move in the negative direction at the same time.

The last is the supposition on which MM. Weber and Kohlrausch* proceed, who have found

$$\tfrac{1}{2}E = 155{,}370{,}000{,}000 \quad \text{.......................} \quad (130),$$

the unit of length being the millimetre, and that of time being one second, whence

$$E = 310{,}740{,}000{,}000 \quad \text{.......................} \quad (131).$$

Prop. XVI.—To find the rate of propagation of transverse vibrations through the elastic medium of which the cells are composed, on the supposition that its elasticity is due entirely to forces acting between pairs of particles.

By the ordinary method of investigation we know that

$$V = \sqrt{\frac{m}{\rho}} \quad \text{..............................} \quad (132),$$

where m is the coefficient of transverse elasticity, and ρ is the density. By referring to the equations of Part I., it will be seen that if ρ is the density of the matter of the vortices, and μ is the "coefficient of magnetic induction,"

$$\mu = \pi\rho \quad \text{..................................} \quad (133);$$

whence

$$\pi m = V^2\mu \quad \text{................................} \quad (134);$$

and by (108),

$$E = V\sqrt{\mu} \quad \text{..............................} \quad (135).$$

In air or vacuum $\mu = 1$, and therefore

$$\left.\begin{aligned} V &= E \\ &= 310{,}740{,}000{,}000 \text{ millimetres per second} \\ &= 193{,}088 \text{ miles per second} \end{aligned}\right\} \quad \text{................} \quad (136).$$

* *Abhandlungen der König. Sächsischen Gesellschaft*, Vol. III. (1857), p. 260.

The velocity of light in air, as determined by M. Fizeau*, is 70,843 leagues per second (25 leagues to a degree) which gives

$$V = 314{,}858{,}000{,}000 \text{ millimetres}$$

$$= 195{,}647 \text{ miles per second} \quad \text{.....................} \quad (137).$$

The velocity of transverse undulations in our hypothetical medium, calculated from the electro-magnetic experiments of MM. Kohlrausch and Weber, agrees so exactly with the velocity of light calculated from the optical experiments of M. Fizeau, that we can scarcely avoid the inference that *light consists in the transverse undulations of the same medium which is the cause of electric and magnetic phenomena.*

PROP. XVII.—To find the electric capacity of a Leyden jar composed of any given dielectric placed between two conducting surfaces.

Let the electric tensions or potentials of the two surfaces be Ψ_1 and Ψ_2. Let S be the area of each surface, and θ the distance between them, and let e and $-e$ be the quantities of electricity on each surface; then the capacity

$$C = \frac{e}{\Psi_1 - \Psi_2} \quad \text{..............................} \quad (138).$$

Within the dielectric we have the variation of Ψ perpendicular to the surface

$$= \frac{\Psi_1 - \Psi_2}{\theta}.$$

Beyond either surface this variation is zero.

Hence by (115) applied at the surface, the electricity on unit of area is

$$\frac{\Psi_1 - \Psi_2}{4\pi E^2 \theta} \quad \text{..............................} \quad (139);$$

and we deduce the whole capacity of the apparatus,

$$C = \frac{S}{4\pi E^2 \theta} \quad \text{..............................} \quad (140);$$

so that the quantity of electricity required to bring the one surface to a

* *Comptes Rendus*, Vol. XXIX. (1849), p. 90. In Galbraith and Haughton's *Manual of Astronomy*, M. Fizeau's result is stated at 169,944 geographical miles of 1000 fathoms, which gives 193,118 statute miles; the value deduced from aberration is 192,000 miles.

given tension varies directly as the surface, inversely as the thickness, and inversely as the square of E.

Now the coefficient of induction of dielectrics is deduced from the capacity of induction-apparatus formed of them; so that if D is that coefficient, D varies inversely as E^2, and is unity for air. Hence

$$D = \frac{V^2}{V_1^2 \mu} \qquad (141),$$

where V and V_1 are the velocities of light in air and in the medium. Now if i is the index of refraction, $\frac{V}{V_1} = i$, and

$$D = \frac{i^2}{\mu} \qquad (142);$$

so that the inductive power of a dielectric varies directly as the square of the index of refraction, and inversely as the magnetic inductive power.

In dense media, however, the optical, electric, and magnetic phenomena may be modified in different degrees by the particles of gross matter; and their mode of arrangement may influence these phenomena differently in different directions. The axes of optical, electric, and magnetic properties will probably coincide; but on account of the unknown and probably complicated nature of the reactions of the heavy particles on the ætherial medium, it may be impossible to discover any general numerical relations between the optical, electric, and magnetic ratios of these axes.

It seems probable, however, that the value of E, for any given axis, depends upon the velocity of light whose vibrations are parallel to that axis, or whose plane of polarization is perpendicular to that axis.

In a uniaxal crystal, the axial value of E will depend on the velocity of the extraordinary ray, and the equatorial value will depend on that of the ordinary ray.

In "positive" crystals, the axial value of E will be the least and in negative the greatest.

The value of D_1, which varies inversely as E^2, will, *cæteris paribus*, be greatest for the axial direction in positive crystals, and for the equatorial direction in negative crystals, such as Iceland spar. If a spherical portion of a crystal, radius $= a$, be suspended in a field of electric force which would act on unit of