most advantageously communicated. Equability of velocity is obtained, though at the expense of some degree of sliding friction, when the outline of the teeth of the wheels are involutes of circles. Friction, on the other hand, is wholly prevented when their form is the logarithmic spiral; but the angular velocities will then be variable. Hence these two advantages are incompatible with one another; but on the whole, the author gives the preference to the involute, which produces an equability of angular motion. The most advantageous mode of increasing velocity by a series of wheels is to adjust them so that the multiplication of velocity shall proceed in a geometrical progression.

On the Laws of the Polarization of Light by Refraction. By David Brewster, *LL.D. F.R.S. L. & E.* Read February 25, 1830. [*Phil. Trans.* 1830, *p.* 133.]

M. Arago had deduced from some experiments which he made on the polarization of light with plates of glass, that the quantity of light polarized by reflexion is equal to the quantity polarized by transmission, whatever be the angle of incidence. The author of the present paper shows that the views from which this deduction was made, and the observations on which they are founded, are incorrect. By applying to the subject the same principles which he has already developed in the paper lately read to the Society, on the Polarization of Light by Reflexion, he establishes, on the basis of actual experiment, what he conceives to be the true laws of the phenomena. The first step in his inquiry is the determination of the law according to which the polarizing force of the refracting surface changes the position of the planes of polarized light. He shows that when a compound pencil, of which the constituent rays are polarized in planes inclined at angles of 45°, the one being to the right and the other to the left of the plane of refraction, is refracted, the planes of polarization of the refracted rays are turned so as to approach to coincidence, not in a plane parallel to the plane of reflexion, as happens in the reflected rays, but in a plane at right angles to it. This contrariety of effect, he observes, is exactly what might have been expected from the opposite character of the resulting polarization, the poles of the particles of light, which were formerly repelled by the force of reflexion, being now attracted by the refracting force. The author next endeavoured to ascertain the influence of refracting power in effecting polarization, but experienced great difficulty in prosecuting this inquiry, from the necessity of having plates without any crystalline structure. He tried gold leaf in a variety of ways, but found it almost impossible to obtain correct results, on account of the light which was transmitted unchanged through its pores. From observations with films of soapy water, and thin plates of metalline glass of high refractive power, he concludes that the rotation of the planes of polarization increases with the refractive power. By an examination of the effects produced at different angles of incidence, he deduces

the law expressing the variation of the rotation corresponding to the deviation of the refracted ray, when the inclination of the planes of polarization to the plane of incidence is 45°; namely, that the co-tangent of the inclination of the plane of polarization to that of re-fraction, is equal to the cosine of the difference between the angles of incidence and refraction. This formula represents the experiments so accurately, that when the analysing rhomb of calcareous spar is set to the calculated angle of inclination, the extraordinary image completely disappears; a result which is the strongest test of the correctness of the formula.

In order to determine the quantity of polarized light in the refracted pencil, the author follows a method similar to that which he employed for the reflected rays, and which he has explained in his former paper. He deduces as a general result, that the quantity of light polarized by refraction can never be mathematically equal to the whole of the transmitted pencil, however numerous be the refractions which it undergoes; or, in other words, refraction cannot produce rays truly polarized, that is, with their planes of polarization parallel. The same conclusions as were deduced in a preceding paper, respecting the partial polarization of light by reflexion, hold good with regard to similar changes produced by its refraction. Each refracting surface produces a change in the position of the planes of polarization, and consequently a physical change upon the transmitted pencil by which it has approached to the state of complete polarization. This proposition the author illustrates by applying the formulæ to the results of actual experiment, and showing their coincidence.

By prosecuting this investigation, the author arrives at the following important laws, namely, that at the first surface of all bodies, and at all angles of incidence, the quantity of light polarized by refraction is equal to the quantity polarized by reflexion; and also that the reflected is equal to the transmitted light when the inclination of the planes of polarization of the reflected pencil to the plane of the reflexion is the complement of the inclination of the planes of polarization to the same plane.

On the Action of the Second Surfaces of transparent Plates upon Light. By David Brewster, *LL.D. F.R.S. L. & E.* Read February 25, 1830. [*Phil. Trans.* 1830, *p.* 145.]

M. Arago had conceived that he had proved by an experiment, that at every possible angle of incidence the quantity of light polarized by reflexion was precisely equal to that of the light at the same time polarized by refraction. Dr. Brewster shows in the present paper, that the experiment does not warrant this conclusion; as the phenomena observed from it are the complicated effects of various refractions and reflexions from both surfaces of the glass, each affecting the position of the planes of polarization. By varying the form of the experiment in a way which allowed of the observation of these effects when separate, he is led to the following general law; namely,