The examples are numerous, and admit of geometrical interpretation; many of them illustrate the theory of tangential transformations, which, happily, receives a good deal of attention. The articles on existence-theorems appear to be sound, so far as they go, and are unusually readable. Altogether, Dr. Liebmann's book may be recommended as a useful introduction to the modern treatment of the vast subject with which he deals. M.

The Theory of Equations: with an Introduction to the Theory of Binary Algebraic Forms. By W. S. Burnside, M.A., D.Sc., and A. W. Panton, M.A., D.Sc. Fourth edition. 2 vols. Pp. xiv + 286 and xii + 292. (Dublin: Hodges, Figgis and Co., Ltd.; London: Longmans, Green and Co., 1899, 1901.)

IN this new edition of a well-known and popular treatise the principal change is the addition of a chapter on the theory of substitutions and groups. Following the methods of Serret, Jordan and Netto, the authors give just so much of the elementary theory of substitution-groups as to enable them to prove the fundamental property of the Galoisian resolvent of an equation, and to demonstrate that the general equation of any degree higher than the fourth cannot be solved by an algebraic formula. It is strange that no reference is given to the work of Kronecker and others on equations which do admit of algebraic solution.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Note on Electric Charging and Discharging at a Distance.

A NUMBER of experiments, which I began in 1888, continued in 1894 and again in 1896, have been waiting for publication until the completion of certain others that I have been hoping to find time to carry out. As, however, the results are somewhat akin to those on the discharge of insulated bodies that are of great interest at the present time, it may be worth while not longer to delay publishing a preliminary note on a few of them.

The interest of the experiments lies partly in the fact that I was not merely able to *discharge* an electroscope by means of various bodies, hot and cold, placed within distances from it varying between 1 cm. and 300 cm., but that I was also able to *charge* the electroscope by the same means. The special interest, however, arises from *cold* bodies, viz. cotton wool dipped in ether, methylated spirit, or dilute sulphuric acid, being different, so far as I am aware, from any that have hitherto been employed for discharging or charging an electroscope at a distance.

A gold-leaf electroscope was employed, its outer case properly screened with strips of tinfoil, and the knob replaced with a metal pot to increase its capacity. A charge sufficient to make the leaves diverge by rather more than a right angle was generally given, so as to render the collapse easy to see. In every case the sign of the charge was tested before it was noted.

I.—*Discharging an Electroscope at Short Distances by means of a Candle Flame.*—With an insulated candle flame at 15 cm. distance, the leaves collapsed in forty seconds, whether they were charged positively or negatively. At 40 cm. between the two, the positive charge leaked away more slowly than the negative. With 42 cm. distance, the leakage was very slow for both, and at 48 cm. there was none.

When the candle was earthed, by having a wire sticking into the wick, the discharge was quicker than when it was insulated, but not if the wire dipped into the melted wax. The flame of a match had no less power, and an electric arc no more power, than an uninsulated candle flame placed at the same distance.

II.—*Discharging an Electroscope at Long Distances by means of an Insulated Candle.*—The candle and the electroscope were next placed 150 cm. apart and a *negative* charge given to the electroscope. Result—no leakage. A glass rod was then rubbed, brought up to the candle on the side *remote* from the electroscope, and then withdrawn. When this had been done several times, the leaves began to collapse, and collapsed in jerks, each time the rod was excited, brought near the candle and withdrawn. The collapse appeared to take place at the withdrawal of the rod. The same experiment was performed with distances varying up to 200 cm. between the candle and electroscope, and the numbers of withdrawals and re-excitations of the glass rod that were needed before the leaves began to collapse were noted. It varied from 1, with a distance of 125 cm. between candle and electroscope, to 14, with a distance of 203 cm. Thus the number of excitations increased very rapidly with the distance. The same results were obtained by charging the electroscope positively and bringing rubbed sealing-wax up to the candle. The further the distance of the two apart, the longer was it before the leaves began to collapse and the slower was the collapse when it began.

III.—*Charging an Electroscope at Long Distances by means of an Insulated Candle.*—All the experiments in II. were repeated, but the electroscope and the candle were now charged with the *same* sign. The number of withdrawals before the leaves began to move was much the same as before, but now the leaves diverged more widely, whether both electroscope and candle were charged positively or negatively. The electroscope was then left uncharged, and the charge rod was brought up to the candle as before. The leaves then diverged, and were found to have a charge of the same sign as that of the rod. Thus a charged electroscope placed at a distance up to 200 cm. from an insulated candle can be discharged by repeatedly bringing a charge of the *opposite* sign near the candle, on the side remote from the electroscope, and, similarly, an uncharged electroscope can be charged with a candle and rod placed at distances up to 200 cm. from the electroscope.

IV.—*The same Experiments with an Earthed Candle Flame.*—None of the results in III. are obtained if the candle is earthed.

V.—*Discharging an Electroscope by means of a Red Hot Platinum Wire.*—I., II., III. and IV. were repeated with the candle replaced by a platinum wire kept red hot by a current from two Grove's cells, which were placed on a cake of sealing-wax standing on four cubes of paraffin wax when the cells were required to be insulated. The results were practically the same as with the candle flame, except that the platinum wire, when earthed, discharged a negatively charged electroscope, but not one positively charged. Also when it was insulated, it discharged the electroscope at as great a distance, in one case, as 300 cm. from it.

Since writing the preceding, I find that some experiments on discharging, and discharging by means of *hot* bodies placed at *short* distances from the electroscope, were described by Prof. Worthington at the meeting of the British Association in 1889.

VI.—*To Restore to Platinum Wire the Power to Discharge when it has lost it by being kept White Hot for many hours.*—Prof. Schuster first observed, I believe, that glowing platinum wire ceased to discharge electrified bodies near it after it had been kept white hot for some time. He attributed its discharging power to occluded gases and the loss to these having all been expelled. To see if the power could be restored to the wire by placing any substance on it, I first put a drop of oil on some wire that had lost its power, but with no effect. A grain of sugar was equally ineffectual, &c., but either salt or common washing soda was, I found, instantly efficacious. It seems possible, therefore, that it is some trace of a salt of sodium or other metal on an ordinary platinum wire that either enables, or assists, the hot wire to discharge, and that the white heat chemically cleans this off. I intend, however, to make further experiments on this point.

VII.—*Charging and Discharging an Electroscope by means of Cotton Wool dipped in Ether, Methylated Spirit, or Dilute Sulphuric Acid—the whole Insulated.*—II., III. and IV. were next tried, when the candle flame was replaced with an insulated saucer of cotton wool, saturated in turns with ether, methylated spirit and dilute sulphuric acid placed at a distance from the electroscope. Each was found to act just as well as the candle flame and in the same way. None would act when earthed, and carbon dust—dry—was quite ineffectual in both cases.

Many other experiments were tried, but the preceding are sufficient to show the nature of the phenomena observed.

HERTHA AYRTON.