

"original cow." Just below or on the line ( $\beta$ ), vertically above the *first cow*, and, like it, erect, would be a *second cow*, a repetition of the first. And often, above this again, below or on the line ( $\gamma$ ), would be a third cow, also erect.

Sometimes there were confused images hanging from the *second cow* and joining other confused images piled on the *first cow*; sometimes the first cow was clear of images, while they hung down from the second cow; sometimes the second cow was clear, and there were images piled on the first. Often the *third cow* was missing (see Fig. 1). As the original cow moved, these images changed their disposition or vanished, and the third cow appeared or vanished. But in all these changes it seemed to me that the *first cow*, *second cow*, and (when visible) the *third cow*, were the permanent images. These, it appeared, were always erect.

(3) After the sun had risen, all continued *in statu quo* for a short time. But soon, at various parts of the horizon, the land just above the edges ( $\alpha$ ), ( $\beta$ ), and ( $\gamma$ ) paled away, and finally melted into the appearance of "sky" or "water." There were left, in the later stages of the mirage, first, the plain itself, with an extension, the limits of which were not sharp, beyond the normal horizon; secondly, above this a strip of land, apparently suspended in the air; thirdly, in some parts of the horizon another strip of land suspended in the air above this again. The interval between ( $\alpha$ ) and ( $\beta$ ) was in all stages greater than that between ( $\beta$ ) and ( $\gamma$ ). One of the appearances in the later stages is indicated in Fig. 2.

Other changes crept in, too. Very often the original objects were wholly or partly sunk out of sight; the images were less defined; and the confused images hanging from the *second cow*, e.g., or piled on the *first cow*, were now seen in the watery layers, sometimes bridging it over.

(4) As time went on, the watery layers widened. The images, too, became still vaguer, and the original objects were usually out of sight or only just indicated above the line ( $\alpha$ ). Moreover, the aerial images, with their confused trails of images hanging from them, began to assume more the appearance of "inverted images suspended over objects hidden below the horizon."

(5) In these later stages, no doubt, anyone would have guessed that the aerial images were indeed very vaguely defined *inverted* images. But to me, as I followed the phenomenon from the beginning, it seemed that they were not so. It seemed to me that each aerial image was really topped by an *erect* image, which, with the trails hanging from it, seemed like an inverted image. At least I can say that, so long as the images were well defined at all, I never made out a clear case of the *main*, or permanent, aerial images being inverted. Thus, as the *first cow* moved, it was the erect *second* (and sometimes *third*) *cows* that remained clear.

(6) In these later stages it was only trees and houses that could be seen in the mirage, and these were ill-defined.

(7) The mirage lasted until about an hour and a quarter after sunrise. The last traces of aerial images of land appeared just under the sun, and in that part of the horizon that lay just opposite to it. Whether the abnormal extension of the horizon entirely ceased at the same time, I cannot say; but there did not remain any noticeable extension.

(8) As with the summer mirage, I found I could alter appearances by altering my level above the earth. But the change in level had to be more considerable. I have no good notes on this matter; but I believe that usually I could recover a past stage of the mirage by a sufficient descent down a ladder from my post of observation.

*General Conclusions as to Winter Mirage:—*

(1) It is due to the earth, and the air near it, being considerably chilled below the temperature of the rest of the atmosphere.

(2) The phenomena of extended horizon and multiple images are to be observed.

(3) The "drawn up" appearance of objects is really due to a number of images piled upon one another, only to be separated by the use of a telescope.

(4) No case of a terrestrial object having above it a single inverted image, or images of which the uppermost was inverted, came under my notice.

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### SCIENTIFIC SERIALS.

*American Journal of Mathematics*, vol. xii. No. 1, and index to vols. i.-x. (Baltimore, 1889).—This volume opens with

an instalment of sixty pages of a memoir by A. R. Forsyth, F.R.S., on "Systems of Ternariants that are Algebraically Complete." In this the writer has found it convenient to use "ternariant" as a generic term for concomitants of ternary quatics, instead of giving it the signification which Prof. Sylvester proposed (*Amer. J. of Math.*, vol. v. p. 81) to give to it, viz. the leading coefficients of those concomitants." The memoir is divided into three parts, and deals with the theory of the algebraically independent concomitants of ternary quatics, taking as the starting-point the six linear partial differential equations of the first order satisfied by them. References are supplied to numerous memoirs on the subject.—Captain (now Major) P. A. Macmahon continues (pp. 61-102) his investigations (vol. xi. No. 1) in a "Second Memoir on a New Theory of Symmetric Functions." Herein he is engaged with functions which are not necessarily integral, but require partitions, with positive, zero, and negative parts for their symbolical expression. The author thus summarizes his results: (1) a simple proof of a generalized Vandermonde-Waring power law which presents itself in the guise of an invariance property of a transcendental transformation; (2) the law of "groups of separations"; (3) the fundamental law of algebraic reciprocity; (4) the fundamental law of algebraic expressibility which asserts that certain indicated symmetric functions can be exhibited as linear functions of the separations of any given partition; (5) the existence is established of a pair of symmetrical tables in association with every partition into positive, zero, and negative parts, of every number, positive, zero, or negative.—The closing portion of the number (pp. 103-114) is taken up with an article entitled "De l'Homographie en Mécanique," by P. Appell.—A likeness of M. Poincaré faces p. 1.—The index is of a twofold description—of authors and of subjects. From the forewords we learn that papers have been published from eighty-nine contributors; these comprise "most of the leading mathematicians of the world."

### SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, November 11.—M. Hermite in the chair.—Presentation of Report of Proceedings of the permanent International Committee for preparing a photographic chart of the heavens, by M. E. Mouchez. Fifteen Observatories will be ready by the middle of next year; and five others before the end. The zones are indicated.—Note of M. Daubrée with descriptive catalogue of the meteorites of Mexico prepared by M. Antonio del Castillo. Meteorites are abundant in Mexico. A remarkably wide area of dispersion is indicated by three portions of one mass, found at the angles of a triangle, whose two longer sides were 90 km. and 60 km. In one of these places two plates were found 250 m. apart; and they seem to have formed one huge plate over 24,000 kgm. weight, which broke near the ground.—On the incineration of vegetable matters, by M. G. Lechartier. Trying various methods, he finds, that in the carbonization and incineration of a plant, there is considerable loss of sulphur, volatilized in various combinations; and special precautions are necessary in determining this constituent. Under the same conditions, and care being taken to prevent loss of solid matter carried away mechanically with the issuing gas, there is no sensible loss of phosphorus.—M. Picard was elected member in Geometry, in place of the late M. Halphen.—On a rotating magnetic field formed with two Ruhmkorff coils, by M. W. De Fonvielle. A current from accumulators is sent through the primary of one coil, the secondary of which is connected with that of the other coil, which is in a line with the first, and the primary of which may be open or closed.—On certain ellipsoidal areas, by M. G. Humbert.—On a new calculating machine, by M. L. Bollée. While in previous machines, multiplications, e.g., are done by successive additions, this one has a multiplying apparatus which determines immediately, in one function, the product of a number by each figure of the multiplier.—On the solubility of the chlorides of potassium and of sodium in the same solution, by M. Étard. The results of experiment are shown in graphic form; the curves of solubility of each salt separately being compared with those of the mixed salts, &c. The sum of the dissolved salts is represented by a continuous straight line. The curves for the mixed salts cross at temperature 97°; that for NaCl falling while the other rises.—On an application of thermo-chemistry, by M. A.