clouds; although, according to the best of my recollection, luminous filaments seemed to extend from the clouds for a short distance into the span of the arch. EVAN MCLENNAN.

Brooklyn, Iowa, U.S.A., November 22.

### Electrical Figures.

I RECENTLY noticed a pretty form of electrical discharge, which has probably been described before, but was new to me. Perhaps one of your readers will be able to refer us to an account of it.

The poles of a Voss machine are put very near together: a plate of ebonite $\frac{1}{16}$ inch thick is placed between them. As the machine works, a succession of delicate ramified discharges run over both surfaces of the plate: they are bright green, and each crooked line is discontinuous—a series of dashes, as if stitched out in silk, now above and now below the surface.

Winchester College, December 6. W. B. CROFT.

## *NEW DOUBLE STARS.*

THE highest quality of seeing, as of acting or of thinking, needs initiative. A mental impulse is the spring of discovery, even by a purely visual process. The mind prompts the eye, interprets what it suggests, bodies out its semi-disclosures. So that to perceive what has never been perceived before is, in a sort of way, an act of *invention*. It thus happens that an accurate is not always an original observer. Novelties, as such, are almost inaccessible to many persons with exquisite powers of vision for whatever is already known to be within its range.

The late Baron Dembowski was an example of a first-rate observer but slightly endowed for detection; Mr. Burnham, on the other hand, is a born discoverer. The accidents of his career have turned his attention almost exclusively to double stars; and his glance seems to have a compulsive power of turning simple into compound objects by long and intent looking. His Chicago thousand of new pairs are famous; he bids fair to accumulate an equally imposing array at Lick. Nor does he neglect the old in the search for the new. The more exciting is not permitted to exclude what is in many respects the more useful occupation.

Progress in double-star astronomy is absolutely dependent upon remeasurements of the relative positions and distances of known pairs. We can otherwise learn nothing as to the nature of their connection. Inquiries about them can, by this means alone, be pushed through the three successive stages leading up towards complete knowledge. In the first place, it has to be decided whether the stars shift their places perceptibly with reference one to the other. If they are "fixed," but with a common proper motion, then they may safely be set down as physically coupled, although centuries may elapse before the character of their mutual revolutions becomes apparent. In the next place, the nature of relative motions, where they exist, has to be ascertained. Should they prove to be rectilinear, that fact alone overthrows the possibility of any real connection between the stars. Each pursues its way independently of the other. Finally, in the interesting cases in which curvilinear motion shows itself, persistent micrometrical measures are required to determine the shape and period of the orbit traced out.

Yet the majority of these objects receive little or no attention. This is in part due to their great numbers. About 12,000 double stars—using the term in the widest sense—are now known; nearly 5000 are in really close conjunction—so close, in some 1400 instances, as to render the chances of accidental juxtaposition all but evanescent. Only between fifty and sixty stellar orbits have, however, as yet been computed, and many of them from most inadequate data. The truth is, that this branch of work wants organizing. It is too vast and too important to be abandoned to the capricious incursions of irresponsible amateurs, whose industry is often wasted by being misapplied. There ought, nevertheless, to be little difficulty in distributing the observational resources available as advantageously as possible by the intervention of some recognized authority, a central repository being at the same time constituted whence computers could obtain on demand the materials needed for the investigation of particular systems. The tasks of stellar astronomy are so multitudinous as imperatively to demand combination for their effectual treatment.

Discovery, meanwhile, must advance as it can. It is far from desirable that it should remain stationary. Although our acquaintance among double stars is already embarrassingly large, we cannot refuse to extend it. Every addition to it, indeed, is, for a variety of reasons, to be welcomed.

Information on the general subject of stellar compositeness can only be gained by continually widening the area of research. The comparative frequency of its occurrence can thus only be estimated. Struve found one in forty of 120,000 stars examined by him down to 1827 to be compound; but the proportion was naturally higher for the brighter stars, as being in general much nearer the earth, and consequently of more facile optical separation. Every twenty-fifth star in Piazzi's Catalogue, every eleventh in Flamsteed's, proved accordingly to have a companion within less than 32″. But the process of dividing stars has since made such strides as to show that the real preponderance of single over double ones must be much smaller than these numbers indicate. Perhaps, indeed, no star can be called absolutely single. Between a small companion sun and a large planet in its self-luminous stage it is not easy to establish a distinction. The star we know best may not always have been, in its "surpassing glory," so undeniably solitary as it now is. Jupiter, if it ever shone with anything like stellar lustre, would have constituted with it a fine unequal pair such as are plentifully exemplified in our catalogues.

The distribution of double stars is characterized by a somewhat irregular condensation towards the Milky Way. They abound in Cygnus and Lyra, are scanty in Cassiopeia and Cepheus; while Struve met with rich regions where lucid stars are few, in Auriga, Telescopium, and Lynx. Burnham, however, could detect no marked local preferences among his numerous pairs. Sir John Herschel was struck with the paucity of close doubles in the southern hemisphere; but no searching scrutiny has yet been carried out there with modern instruments.

The curious tendency of stars already in close association to split up still further when sufficiently powerful means are brought to bear upon them, has been strongly accentuated by Mr. Burnham's investigations. Primaries with double satellites, such as Rigel, or satellites with double primaries, such as $\xi$ and $\beta$ Scorpii, swarm on his lists. A fresh instance of the former kind is $\zeta$ Piscium ($\Sigma$ 100), registered by Struve as somewhat widely double, but found to be triple last autumn with the Lick twelve-inch achromatic. The satellite of Struve's companion, at an interval of less than one second from it, is of the eleventh magnitude. The bright stars are estimated by Burnham as of sixth and eighth, but were photometrically determined at Harvard as of 5·4 and 6·4 magnitudes; and Webb thought that the chief of the pair occasionally rose to the fourth rank of lustre. A presumption is thus afforded that both fluctuate in light. Their spectrum, like that of most variable double stars, is of the Sirian type; and their real fellowship is made manifest by a community of proper motion. We have here, then, a genuine ternary system.

Aldebaran is the centre of a mixed group. A small star at 30″ detected by Mr. Burnham at Chicago on October 31, 1877, was described by him as making with the ruddy bright star, a pair resembling Mars and his outer satellite (*Astr. Nach.*, No. 2189). A drift together through space