the lightning with its low dull thunderous sound continued for more than an hour, after which the sky became darker and darker; rain mixed with hailstones fell, and lightning accompanied with thunder, furrowed the sky in all directions.—*Nature*.

IMPROVEMENT IN DYNAMO-ELECTRIC MACHINES.

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THIS invention relates to certain improvements in dynamo-electric machines, designed to produce alternate currents in opposite directions, for the production of electric lights or other purposes, as well as currents invariable in direction.

Fig. 1, A, represents a series of inducing-magnets, arranged radially about an axis, so as to revolve therewith, while B represents a series of induced magnets, which are made stationary, and project inwardly toward the inducing-magnets. These induced magnets B serve each as so many independent sources of electricity of alternately reversed currents, and may be utilized for producing any number of electric lights, or for other purposes. To excite them, however, it is necessary that the inducing-magnets A be rotated and charged by an electric current invariable in direction. For thus charging the inducing-magnets A, I employ the device for producing said invariable currents, which is illustrated in Fig. 2.

In this case the relation of the induced to the inducing magnets is the reverse of that shown in Fig. 1, in that the inducing-magnets A¹ A² are here stationary, while the induced magnets of the wheel are movable.

This induction-wheel P consists of a metallic shaft, upon which are arranged radial arms at right angles to the axis, which arms form cores of the magnets D'. Each of said cores is provided with a coil of covered copper wire of which the ingress end E of one coil is connected with the egress end S of the next coil, so as to form a series of induction-coils, connected together in such a way as to produce a circuit completely closed upon itself. The extremities of each of these coils is electrically connected at C' with insulated contacts C upon the boss of the wheel, and upon which contacts the rubbers or springs a' bear in the line XX, to take off the currents which are invariable in direction.

To understand the effect produced by imparting rotary motion to the induction-wheel in front of the poles of a magnet or electric magnet, it is necessary to refer to the action of magnetism upon coils having iron cores.

In an induction-coil consisting of an iron core with a certain length of copper wire wound around it, the two extremities of the wire constitute the two poles of an instantaneous battery, if the central iron core is submitted momentarily to the influence of a magnet. The current produced is different according as the coil is presented to the north or south pole of the magnet, and according to whether the pole is approaching or receding, which effects may be thus enunciated:

First, when an induction coil is made to approach a negative pole, there is produced in the wire of the coil an induced electric current in the inverse direction to that of the inductor (a magnet being considered as a solenoid, according to the theory of Ampère).

Second, if the same coil is made to recede from the same pole, the direction of the current is reversed. It is then direct—that is to say, in the same direction as that of the inductor.

Third, when an induction-coil approaches the south pole of the magnet, the electric current produced is in the same direction as that which would be produced if it were made to recede from the north pole.

Fourth, when approaching the north pole and receding from the south pole, the effect produced is the same, but inverse as regards general direction to that indicated in clause third.

These four laws being premised, suppose an induction wheel, P, to be rotated, as before stated. If the axis of this wheel be in the polar line XX of a magnet or electro-magnet, the effect in accordance with the third law will be that all the coils above the polar line produce a current in one direction, as indicated by the small arrows, since they are all approaching the south pole and receding from the north pole. The coils below the polar line, approaching the north pole and receding from the south pole, also produce a cur-

rent in one direction, but inverse to that of the coils above the line.

The magnetic polar line XX thus really divides the coils of the induction wheel into two equal series—those above the magnetic polar line and those below the same—while the enveloping wires of the coil are still connected together, so as to form a completely closed circuit.

If the electricity generated in the upper series of coils is generated in the opposite direction in the lower series, there will be in the magnetic polar line on the one side a double positive pole, pp, and on the other a double negative one, nn, so that if by two conducting rubbers or blades, a a', contact with the insulated plates of the coils is established on the line of the double positive pole pp and the double negative pole nn, we have the two poles of a powerful source of electricity, yielding a current invariable in direction; and if I employ a part of the electricity produced to excite the electro-magnets A¹ A², as indicated in dotted lines, I secure a constant and automatic supply of electricity of invariable current. The primary source of the current is supplied by the feeble residual magnetism of the electro-magnets A¹ A², or by charging them once for all.

The invariable induction currents, which are at first very weak, are collected by the two rubbers, as they are produced and returned into the electro-magnets A¹ A², which thus become gradually stronger, and consequently produce in the coil induction currents of increasing intensity as the rotation is accelerated. These currents are continuous, and become constant as soon as the speed of rotation is maintained constant.

In constructing the inducing electro-magnets A¹ A², I prolong the cores of the same, and locate upon said prolongation separate coils C¹ C², in which coils induced alternate currents of opposite direction are produced, so that by the single device illustrated in Fig. 2 both currents invariable in direction are produced (taken from rubbers a a'), and alternate currents in opposite direction (taken from coils C¹ C²), and this, too, without the use of additional rubbers and a commutator for the said alternately reversed currents.

Now, if a number of separate sources of electricity of alternately reversed currents is desired for producing any number of electric lights, or for other purposes, the device illustrated in Fig. 1 is combined with that illustrated in Fig. 2, after the manner shown in Fig. 3, and the invariable current which is taken from the rollers a a' through the coils A¹ A² is passed through the revolving inducing magnets A by means of additional rubbers G G', and the magnets A, being excited thereby, produce, in working alternate currents in opposite direction in the stationary magnet B, each of which constitutes then an independent source of electricity for the production of a number of electric lights, or for similar purpose.

Fig. 1.

THE ASTEROIDS.

By PROFESSOR C. A. YOUNG.

EVERY now and then the papers announce the discovery of a new planet. The occurrence, indeed, has become so frequent of late as to attract very little notice except from professed astronomers, and they, to speak the truth, are none too cordial in the welcome of the little strangers thus added from time to time to the already embarrassingly large family under their charge. For while these new planets are quite as troublesome to provide with ephemerides and orbits as their larger sisters, they are extremely insignificant as regards their importance in the economy of the solar system, being seldom more than forty or fifty miles in diameter, and, as individuals, entirely without sensible influence upon the motions of other heavenly bodies. We say as individuals, because they belong to a numerous group known as the Asteroids (so called because they look like little stars), and the united attraction of the whole family does produce upon the orbit of Mars a perfectly sensible, though very minute, effect, from which Leverrier has computed that the combined mass of the whole flock would suffice to make up a globe not exceeding one-third the size of the earth, and probably a good deal smaller.

At present the number of these bodies known is 172: the whole number is probably to be reckoned by thousands, since it would take more than five hundred of the largest of them to make up the mass named.

Ceres, the first of them, was discovered on the first day of the nineteenth century, that is, January 1, 1801.

It had been noticed nearly two hundred years before, by Kepler, that the progression in the numbers representing the distances of the planets from the sun is such as to suggest the existence of an invisible body in the space between Mars and Jupiter, and he at one time went so far as to predict its discovery. He abandoned the idea, however, supposing that in his celebrated, but fantastic, theory of the polyhedrons he had found the key to the mysteries of the planetary system. Titius, in 1772, revived the original suggestion, and gave to the law of distances nearly the same form as that in which it was stated a few years later by Bode.*

In 1781, Uranus was discovered at a distance from the sun so closely corresponding with the law as to satisfy astronomers that it could be no mere accidental coincidence; and to confirm them in the belief that there must be a missing planet outside of Mars. The impression was so strong that an organization of twenty-four astronomers was formed by the exertions of Baron Zach, to search for it. Curiously enough, however, the good fortune of discovery did not fall to any one of their number, but to Piazzi, the Sicilian astronomer, who, on the opening night of the century, in the course of observations for his famous star-catalogue, came upon a star of the seventh magnitude, in a place where a short time before he was sure no such object existed. In a single day its motion was sufficient to prove its planetary character, and he continued to observe it, though much hindered by ill health and unfavorable weather, until it was lost in the rays of the sun. He was the only observer, however, for in those days communication was so slow that the planet had disappeared before the Continental astronomers could be notified of the discovery; and to find it again was hardly less difficult than at first. Gauss, then just beginning his career, came to the rescue with a new and entirely original method, by which

* The law is generally, but unjustly, known as Bode's, and may be stated thus: set down a row of 4's, as many as there are planets. To the second 4 add 3; to the third 4, twice 3; to the fourth, four times 3; and so on, each time doubling the number added. The result is as follows:

	2	3	4	5	Asteroids.	6	7	8	9
4	4	4	4	4	(4)	4	4	4	4
A 4	3	6	12	24	(24)	48	96	192	384
B 4	7	10	16	28	(28)	52	100	196	387
	7	10	15	28	28	52	85	102	300

The line A gives the numbers derived from the rule, and the line B the actual distances, correct to the nearest unit. While the agreement is generally close, it will be seen that in the case of Neptune the law breaks down completely; but Neptune was not discovered until 1846.

Fig. 3.

LONTIN'S IMPROVEMENTS IN DYNAMO-ELECTRIC ENGINES.