both sides every minute, the mean value being plotted as ordinates with respect to an axis of abscissæ representing time. From this curve the position of equilibrium about which the oscillation occurs was ascertained.

The air current due to the rapidly rotating fly-wheel at first produced some disturbance of the oscillation phenomena. This was overcome by surrounding the rotating parts with a casing (see Fig 2). The top then began to perform quite regular precession oscillations, no departures between the astronomical earth rotation and that inferred from these terrestrial motion phenomena being noted. The minimum speed available for these experiments was found to be 1,500 revolutions per minute.

The theory of the experiment, as given by Prof. Föppl, in the Physikalische Zeitschrift (No. 14, page 419, etc., 1904), is simple enough, if the precession oscillation be at first left out of account. Let the moment of inertia of the rotating masses be denoted by θ, their constant regular speed by w, and the angular speed of the rotation of the earth (supposing that this agrees with the astronomical earth rotation) with u. Let further φ be the geographical latitude of the place of observation, ψ the angle formed by the equilibrium position of the rotating top with the east-west direction, and M the moment of the couple transmitted from the suspension to the top frame in a horizontal plane. M should be equivalent to the vertical component of the speed of variation of the impulse of the top due to the rotation of the earth. The speed of variation of the impulse of the top will be equal to the product of the impulse itself and the angular speed of the rotation of the earth, being considered as a vector. The following equation is obtained:

$$M = \theta\, w\, u \cos \varphi \cos \psi.$$

The moment of inertia is found by calculation to be $\theta = 26.7$ cm. kg. sec²; the geographical latitude was 48 deg. 8 min. 20 sec., and M practically proportional to the torsion of the suspended system with respect to the zero position when the top was at rest, thus equivalent to $c\ \chi$, χ being the angle of torsion, and c being 2.12 cm. kg.

The observations of the deflection of the top due to the rotation of the earth were relative only to the two cases when the zero position of the top at rest is either in the meridian or at right angles to it. In the first case there should be no deflection of the top's axis due to the rotation, provided the astronomical earth rotation also governs terrestrial motion phenomena. This was indeed brought out by the experiment.

When the top's axis at rest is perpendicular to the meridian, the angle of torsion χ to which the moment M is proportional will coincide with the above angle ψ, the equation to be tested assuming the form:

$$c\, \psi = \theta\, w\, u \cos \varphi \cos \psi.$$

As an agreement within 2 per cent was found to exist between the angular speed of the rotation of the earth as derived from these terrestrial motion phenomena and the astronomical earth rotation, it seems likely that this agreement is as perfect as can be hoped. The experimenter hopes, however, to improve his apparatus and to ascertain whether some indications of possible departures are due to errors of observation.

A UNIQUE COLLECTION OF RARE BIRDS.

BY HARRY DILLON JONES.

The Academy of Sciences of Philadelphia has always prided itself on possessing the most complete collection of birds in the world. Of late years Washington and New York have been struggling for supremacy in the ornithological world, and the Quaker City scientists have been quietly adding to their collection, in order to maintain the proud position allotted to them as long ago as 1857, when Dr. P L. Sclater pronounced the collection of birds in the Academy of Sciences to be superior to that of any museum in Europe, and therefore the most perfect in existence. Prof. Witmer Stone, the famous authority on bird life, has about completed his work of cataloguing the collection in the possession of the Academy of Sciences, and about one-third of the specimens are now on exhibition in the museum of the institution. Two-thirds of the collection will remain in air-tight and light-tight cases, where they will be at the disposal of any scientist seeking to add to his knowledge of ornithological subjects. The reason these specimens will not be placed on public exhibition is that they are far too valuable to subject to the deteriorating influence of light and air. It has been found that about forty or fifty years is the duration of the life of specimens placed in cases for public exhibition. Those on exhibition therefore will be specimens of which there are duplicates or those that can be replaced without a great amount of trouble. The very rarest specimens will not be allowed to see the light of day unless the curator of the museum is asked to show them.

Two Interesting Specimens in the Bird Collection of the Academy of Natural Sciences. On Left, Saddle-Backed Stork; on Right, Flamingo.

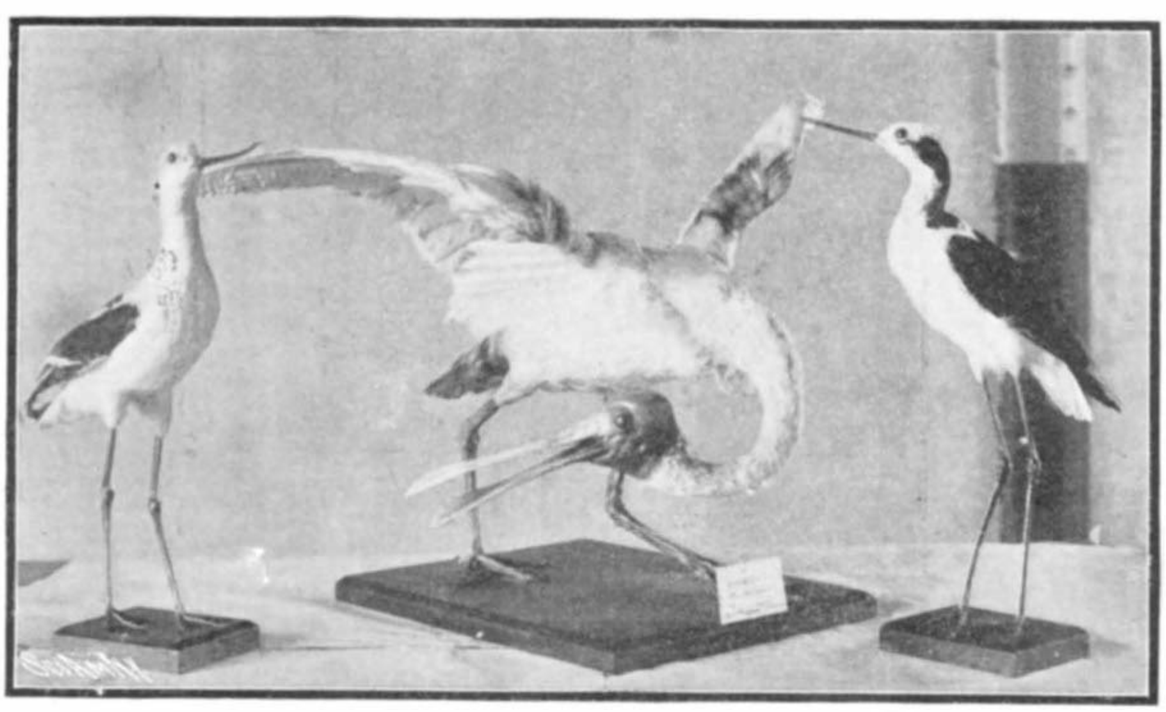
Among the rare specimens is one of the great auk, and one of the eggs of that famous bird. The eggs are even rarer than the birds, for according to Prof. Stone there are only two in America, and a valuation of $500 to $600 is placed on them by collectors. Another rare bird of which there is a specimen in the collection is the Labrador duck. This bird is even more difficult to find than the great auk, for there are not more than forty-two specimens, according to Prof. Stone, in the world. The Sandwich Islands have been hunted over for rare birds, and quite a number of specimens have been brought to the Academy of species that will soon be extinct because of the onslaughts on the forests of the islands and the consequent killing off of the birds of the district. One specimen in the possession of the Academy is absolutely unique, Prof. Stone being unable to give it any name, so extremely rare is the species. It is a bird very similar in appearance to the common American warbler, but has distinctive features that place it in a class by itself.

A Rare Pelican.

That exceedingly shy and scarce bird, the flamingo, is represented by some handsome specimens in the cases at the Academy. Once they were not particularly rare in America, but now there is practically only one flock of them, which is seen by venturesome explorers in the southern part of Florida. The specimens at the Academy were bagged in the Bahamas, where they are still living in sufficient numbers to be found without a long search. The few persons who have tracked these great birds to their haunts have found that they build big nests in uniform rows along the ground. While the female bird is sitting on the nest, the stately male mounts guard by her side. The sight is a remarkable one when an entire flock is seen in this pose.

Among the pelicans of the collection are some from Florida, where they are becoming daily more scarce because of the demand for their plumage for millinery purposes. So far have the birds decreased in numbers, that the United States government has taken a hand in the hunt, and has established a pelican island on the east coast of Florida, as a permanent reservation for the birds, where they can live free from fear of the hunter, and save themselves from extinction because of the greed of the feather collector. At one time the pelican, with his huge bag beneath the beak in which he stored fish for the young, was to be seen as far north as Sandy Hook. Now it is necessary to go to Florida to find him. But for the government's thoughtfulness in setting apart an island for his use, the pelican would probably soon be extinct.

A pheasant with the most wonderful wing development of any of the



In the Center, a Roseate Spoon-bill of Tropical America; to the Right, a Black-Necked Stilt, the Longest-Legged Bird in the World for Its Size; to the Left, the Abocet.

A UNIQUE COLLECTION OF RARE BIRDS.

species in the world is to be seen in the collection. It is known as the Argus pheasant of India, and is seen in one of the accompanying photographs with its magnificent plumage outspread. Like all other birds that nature has provided with fine feathers, this bird is being rapidly hunted to extinction.

In all there are about 48,000 birds in the collection, which has been gathered from all parts of the world by various expeditions sent out by the Academy since as far back as 1812, when the first birds were obtained. Half a century or so ago a great effort was made to place the collection ahead of anything of its kind in the world. Dr. Thomas B. Wilson, president of the Academy, authorized Dr. J. E. Gray, of the British Museum, to purchase specimens in hundred lots. It appeared best, however, to buy established collections that happened to be for sale from time to time, and the splendid collection of Victor Massena, Duc de Rivoli, was bought and transferred to this country. In this collection were 12,500 rare specimens. Smaller collections were bought from time to time, among them the Gould collection of Australian birds and the Boys Indian collection, the latter gathered by Capt. Boys of the British army during his several years' residence in India.

Additions to the collection were made by the Du Chaillu expeditions, sent out partly under the auspices of the Academy of Sciences, and the D'Oca collection from Mexico.

Anæsthesia Without Chloroform.

BY DR. ADOLPHE CARTAZ.

The French surgical society recently discussed the ever-important question of anæsthesia. What is the best means of administering chloroform, the usual anæsthetic, with the minimum danger to the patient and the maximum security for the surgeon? Now and then accidents occur despite the most elaborate care. The patient loses color, his breath fails, his heart ceases to beat, and life is gone. Though he has inhaled the vapor of only a few drops of the anæsthetic, he cannot be roused from sudden and fatal syncope. In order to prevent these accidents, as far as possible, several surgeons have conceived the idea of regulating the amount of chloroform inhaled by mixing it, in various definite proportions, with a known quantity of air. These are uncertain palliatives, and, as one of the surgeons remarked, the greater the elaboration of the apparatus employed, the greater is the danger of a lapse of attention of the assistant who administers the anæsthetic.

During this discussion the application of a new method was reported by MM. Terrier et Desjardins. Method is too strong a word; it is simply the employment of a vegetable alkaloid as an anæsthetic, instead of chloroform or any of the ethers. The idea of this substitution is due to Dr. Schneiderlin, of Baden. What led this surgeon to experiment with this substance? I do not know, for the power to produce general anæsthesia could not be inferred, *à priori*, from its known properties.

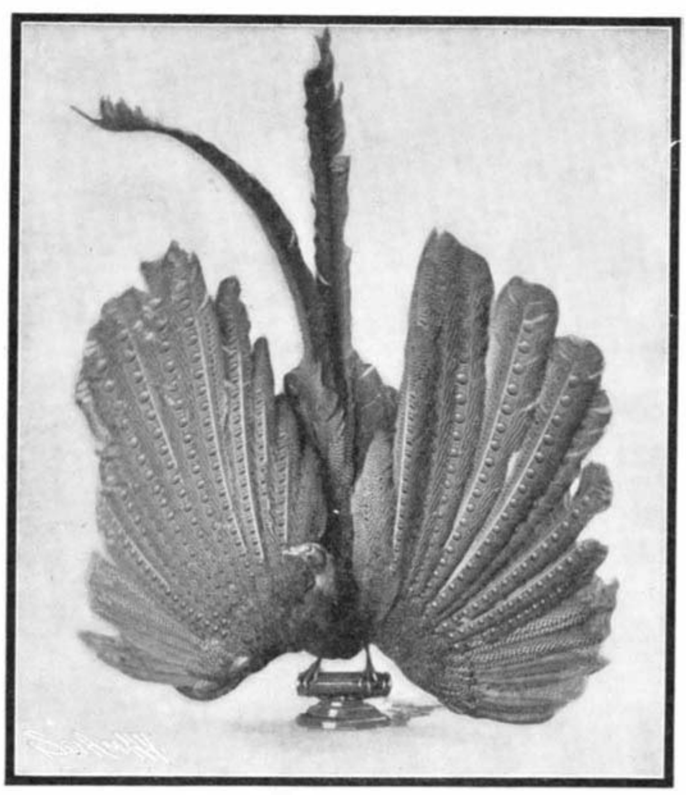
Scopolamine, the alkaloid recommended by Dr. Schneiderlin, was extracted by Schmidt, of Marburg, from the *Scopolia japonica*, a perennial herbaceous plant of the natural order *Solanaceæ*, popularly known as the Japanese belladonna. The first chemical analyses made by Langgaard, long ago, resulted in the isolation of an alkaloid, rotoine (from *roto*, the Japanese name of the plant), which exhibited all the properties of the alkaloids of belladonna. Scopolamine, indeed, exerts a mydriasic and a vaso-dilatory action (i. e., it dilates the pupils and the blood vessels) but it also possesses a narcotic power which inevitably produces a profound and dreamless sleep. Scopolamine has an inhibitory effect on the pneumogastric nerve, which is manifested by a retardation of respiration, an acceleration of the action of the heart, and a narcotic influence on the brain.

Schneiderlin and his school made use of this hypnotic property to produce anæsthesia. They employ a solution containing from a milligramme to a milligramme and a quarter of scopolamine to the cubic centimeter of water, with which they make a first hypodermic injection two hours, a second one hour, and a third one-half hour before the operation. To guard against accident, it is well to add to the solution, by way of antidote, a small quantity of hydrochlorate of morphine, say one centigramme to the cubic centimeter. Fifteen or twenty minutes after the first injection, the patient feels an irresistible desire to sleep. He combats it in vain, rubs his eyes, yawns, then succumbs, like a man exhausted by fatigue, and falls into a calm and natural sleep. After the second injection, his slumber becomes more profound, and his reflex irritability diminishes. If his name is called loudly he opens his eyes, but falls asleep again instantly. After the third injection, the sleep becomes so deep and anæsthesia so complete, that the surgeon is enabled to operate. It is a curious thing that, profound though the patient's slumber appears, it is not so deep that he cannot be roused, as from natural sleep, by a loud shout or noise. But he makes no response to pinching or pricking; his sensibility is gone, and anæsthesia is complete. Hence the operation must be conducted in silence, and the patient moved no more than is absolutely necessary, to avoid rousing him from his torpor. The most interesting feature of the new method, however, is that the anæsthesia per-

The Egret—A Bird Whose Tail Plumage is Much in Demand.

sists so long after the operation, that the patient is spared the painful awakening and the suffering due to the wound and the dressing of it. He sleeps on for several hours after the operation is finished. Some patients awake after five or six hours, take nourishment, and fall asleep again for a longer or shorter time. On waking, they remember nothing of the operation or the events that immediately preceded or followed it. This is, surely, long-lived and effective anæsthesia.

This method, yet unknown in France, has been



The Argus Pheasant of India.

A UNIQUE COLLECTION OF RARE BIRDS.

largely employed in Germany, where more than 1,500 operations have already been performed under its beneficent influence. Prof. Terrier and M. Desjardins have imported it. They have also modified it by combining the anæsthesia of scopolamine with that of chloroform. In some cases they make only a single injection of scopolamine one or two hours before the operation, at which they use a small quantity of chloroform. Whatever the modification employed, this method of producing anæsthesia offers valuable advantages, including the prolonged slumber, the persistence of insensibility on waking, and great freedom from danger, for as yet there is no record of a single fatality attributable to the anæsthetic agent. Cocaine allows us to dispense with chloroform in many operations, but it is available only as a local anæsthetic, while scopolamine puts the patient to sleep, and, according to the surgeons, who have used it, is less dangerous than chloroform. A great advance will be made, therefore, if this agent shall prove applicable to all surgical operations.—La Nature.

South-African Mining—Extent to Which Compressed Air is Used.

In speaking of South African mines in general, it is usual to refer to those in the Johannesburg gold district as typical of the entire country.

In the use of compressed air for mining purposes, the practice in the Witwatersrand represents the highest development of air power to be found in any one mining district. The variety and number of compressor plants in operation is probably unequaled elsewhere.

The diamond mines make little use of compressed air, since the diamond ground is comparatively soft and is drilled by hand jumpers; not even a hammer is needed in the Kimberley mines. The coal mines in Natal have very recently adopted compressed air for coal cutting, but particulars cannot be given here. The Rhodesian gold mines have followed the Johannesburg methods in this as well as other mining matters.

In the Johannesburg district the use of air drills was necessary from the first, as the hard "banket" gold ore cannot be economically developed by hand drilling alone. Owing to the low grade of the ore, the mines can only be successfully worked when large blocks of ground are developed. This condition led to the use of comparatively large compressors from the start, and the usual development through the small semi-portable, or straight-line, compressors did not take place, as is usual in a new mining district.

The early compressors were comparatively small and were extremely inefficient; they were usually of the duplex type, having slide valve steam cylinders, and plain poppet-valve air ends. The discovery of coal within 50 miles of the gold mine made the fuel problem an easy one to solve. It is a curious fact that it was more important to be economical of water than of fuel and for this reason even the earliest plants were run condensing. Coal was close at hand and could be bought, but if the limited water supply failed, operation became impossible. It is no fable that, even after Johannesburg had become a large and important town, water was so scarce that people used bottled soda water for their toilet as well as for diluting their "Scotch."

The present water supply is sufficient only for the existing mines; great additions are in development to provide for the increased demand which will arise in the near future. The result of this condition was the interesting development of the most economical type of compressors, not because of the fuel saving, but because the scarcity of water made condensing engines necessary and the coal economy followed. The present practice aims at both steam and coal economy, and compound condensing Corliss engines with two-stage air cylinders are the standard. The early boiler practice was not in keeping with the engine plants, and many semi-portable boilers were used to drive compound condensing engines. The later practice is to install the most economical boilers regardless of cost; many of them are of the "Lancashire" type so common in English and European plants, but almost unknown in this country.—Mines and Minerals.

When American engineers commenced to build iron bridges, they paid little attention to the then existing European models, but preferred to develop their own systems independently, as they had done previously with wooden bridges, the first iron bridges being imitations of the Towne lattice, and the Howe and Pratt trusses. All the earlier bridges were built principally of cast iron, wrought iron being used in tension members only. In the first iron viaduct built by the Baltimore & Ohio Railroad, in 1852, all parts were of cast iron, except the tie-rods. The wrought-iron tension members at that time usually consisted of round bars with screw ends, or elongated links made of square bars. Later, these links developed into forged eye-bars, introduced by J. H. Linville, M. Am. Soc. C. E., in 1861. These eye-bars have since become one of the distinctive features in American bridge construction. Although flat eye-bars were used in Europe at an earlier period, in chains of suspension bridges and in some types of trusses, they did not find favor there, and were soon discarded for structures with riveted connections.