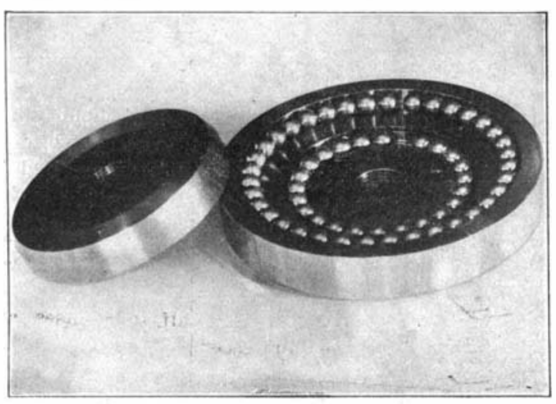
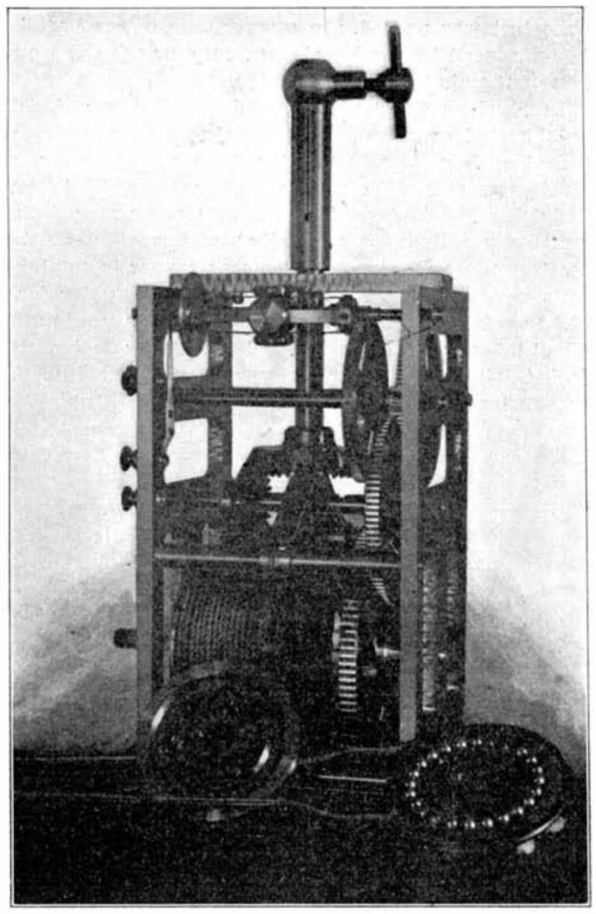
REVOLVING LANTERNS FOR LIGHTHOUSES.

VERY few persons realize the difficulty of making the Fresnel lenses used in our lighthouses. The United States Government has afforded experts in this country every opportunity to learn the art of making these refractors, but up to the present without success. One of the most prominent American optical firms was given one of these lanterns to copy, but after nearly a year of experiment was obliged to abandon the attempt. Consequently Uncle Sam has to send abroad for his lighthouse equipments. There are only four makers of these lenses in the world—one in England, and the other three in France. Most of our equipment comes from the latter country. The difficulty of making these lenses will be realized when one stops to consider that the rays from the lamp must be accurately refracted so as to lie parallel with each other from their source to the pilot house of a vessel just appearing over the horizon, a distance of from 10 to 25 miles, depending upon the height of the lantern above the sea. The variation of a slight fraction of an inch at the lens would obviously be exaggerated many thousand-fold at the horizon. The same holds true in the mounting of the lenses. This is also done abroad, so that whenever a lens is broken it must be shipped back to Europe for repairs. Fresnel lenses have been almost universally used in the lighthouses of Europe and America for half a century; but owing to the isolation of most lighthouses, few people are acquainted with their appearance, or know how they differ from other lenses. In 1822 Augustine Fresnel made a lens whose outer surface, instead of being continuously spherical, was made in steps or concentric zones. The thickness of the lens was thus reduced to a minimum, thereby diminishing the loss of light by absorption in passing through the glass. Most lighthouses are so situated that it is necessary for their light to be spread over the entire circle of the horizon, and in order to meet this requirement Fresnel early in his experiments invented the cylindrical lens—a lens having the shape of the solid generated by revolving the middle vertical section of the ordinary Fresnel lens about a vertical axis. The cylindrical lens bends the rays to a horizontal plane, producing an equal distribution of light in a narrow zone which illuminates the entire horizon. A later improvement on this lens was the use of separate glass prisms or rings of triangular section mounted above and below the main cylinder in such position as to intercept the rays passing upward and downward from the lamp and swing them about into the common, horizontal plane. The use of glass prisms for this purpose was found to effect a great saving over metallic reflectors, due to the fact that the latter absorbed a much larger part of the light. The saving is estimated at nearly twenty-five per cent. In order to afford mariners some means for identifying various lighthouses, a system of flashes has been adopted; that is, while certain lighthouses have a fixed light, others are so arranged as to send out flashes of light at varying intervals of time. The flashes are accomplished by the use of a polygonal frame provided with annular lenses, which is revolved about the lamp by clockwork. This produces a series of beams of light constantly sweeping over the horizon. The mariner then sees a light only when the center of a lens passes directly between his eye and the lamp, and he remains in darkness until the next beam of light comes into line with his eye. Different lighthouses can thus be readily distinguished by varying the number of flashes per minute that the lantern casts. It will be observed that flashing lights are much more powerful than fixed lights, for the light cast instead of being spread over the whole horizon is concentrated into four, six, or eight separate beams. Three types of flashing lanterns are illustrated herewith. The four-sided lantern which we show is not provided with refracting prisms above and below the main lens. It belongs to the fourth order of light, and is the type of lantern used in the Romer Shoal Lighthouse, at the entrance to the New York Lower Bay. This lighthouse, which is shown with the initial of this article, is arranged to send out a flash every four seconds. The revolving lantern has ball bearings on the main standard which supports the clock mechanism. The clockwork is operated by a weight hanging in a shaft extending vertically through the center of the lighthouse.

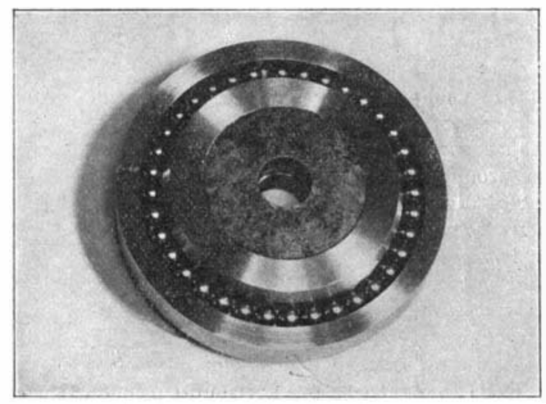
Another engraving shows a more powerful lantern, which is operated by clockwork mounted at one side. This lantern, it will be observed, is provided with the glass prisms above referred to, for utilizing the light which is not intercepted by the main lenses. The lantern is of much higher order, and is mounted



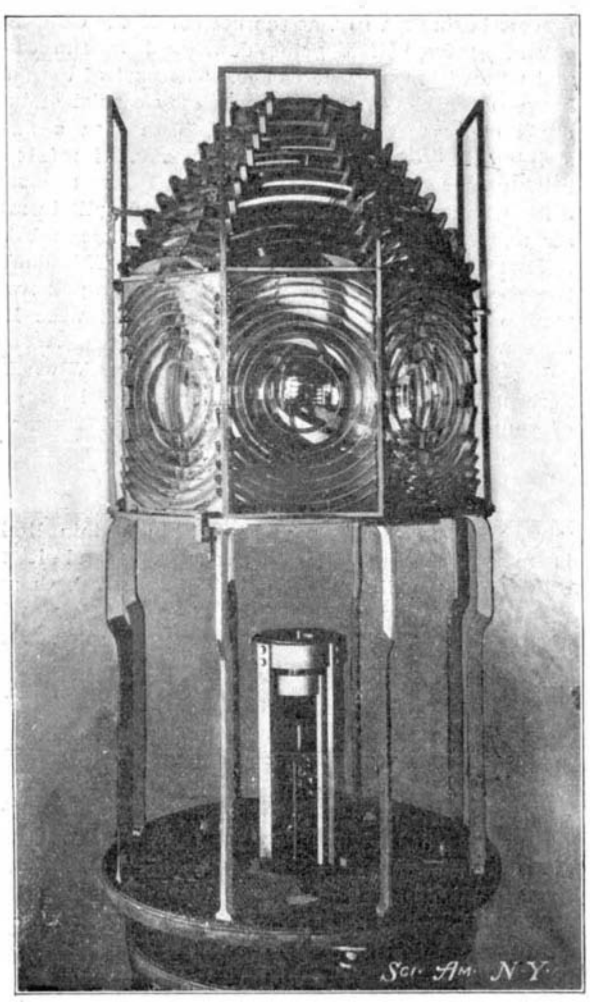
Lower and Intermediate Cones of Lantern Bearing.



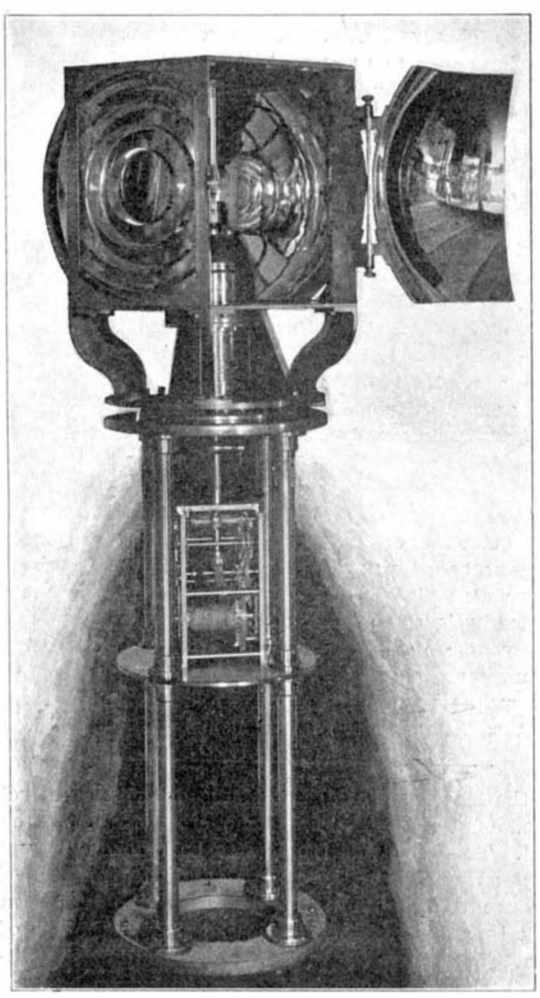
Operating Mechanism for Revolving Lantern.



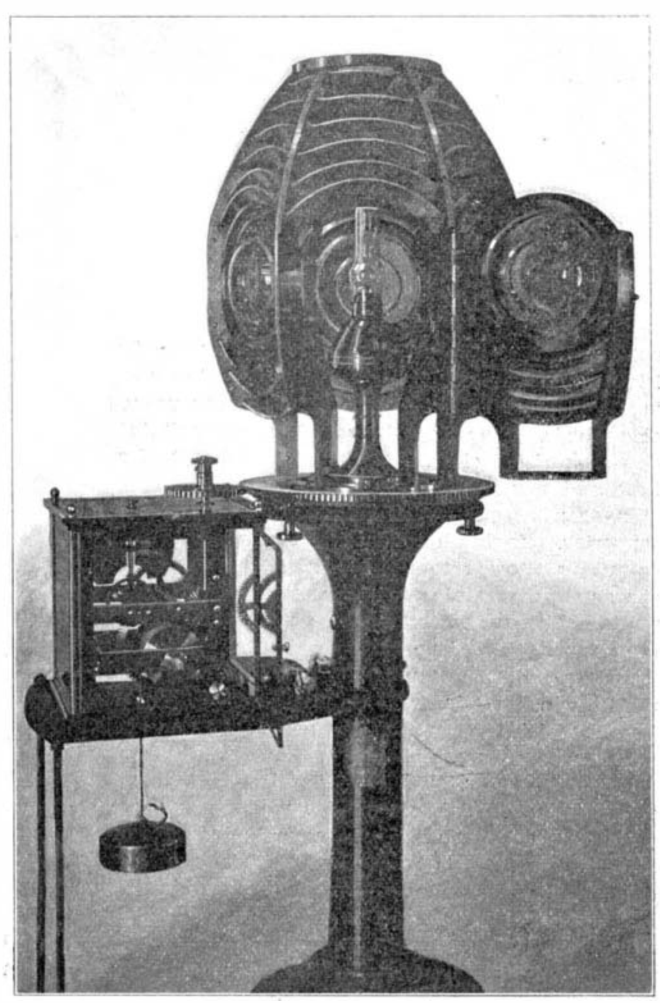
Upper Cone of Lantern Bearing.



Flashing Lantern with Colored Slides.



Four-Sided Flashing Lantern.



Flashing Lantern with Reflecting Prisms.

REVOLVING LANTERNS FOR LIGHTHOUSES.

on an improved type of ball bearing which is illustrated in two of our views. The lower cone of this bearing is provided with two concentric raceways for the steel balls. An intermediate cone has bearing on the inner circle, and over this is placed the upper cone, which bears on the outer circle of balls. This upper member is also provided with a raceway, in which is a series of balls bearing on an outer bearing surface of the lowest cone. As a result of this triple ball bearing, friction is reduced to a minimum, and a lantern thus mounted has actually been revolved by the breath of a man blowing on the lenses.

The third type of lantern illustrated herewith is one adapted to cast different colored flashes of light. The revolving lantern is provided with frames placed before every other lens. These frames are adapted to receive sheets of colored glass. Ordinarily, red glass is used, and the effect would then be, first a flash of red and then one of white, and so on in alternation.

THE BESSEMER COPPER PROCESS.

THE LATEST METHOD OF COPPER CONVERTING, ACCORDING TO PAUL DAVID.

As is well known, nearly all copper is now produced according to the Bessemer method, by blowing compressed air through the matte, whereby the oxygen of the air oxidizes the sulphur of the metallic sulphides, which escapes as sulphur dioxide. In this formation of sulphur dioxide a great amount of heat is liberated, which is sufficient to keep the matte molten for a long time.

When John Holloway made experiments in England in 1878-79 with a common Bessemer converter as used in producing steel, he did not succeed in producing pure copper, and it was maintained at the time that the cold air rushing through the melted copper produced partial solidification, and thus made an end to the process.

In producing steel in the Bessemer converter, the blast of air is forced through the bottom of the converter from below, and passes up through the molten cast iron. In the year 1883, Pierre Manhès and Paul David succeeded in bringing the Bessemer converter into use for raw copper matte. They placed the blast orifices horizontally in the converter about 30 cm. above the base. The great advantages of the process were immediately recognized in America, where at present this process is used in all copper smelters. It is of course only practicable where the ores contain a certain percentage of sulphur, for in the Lake Superior district, where unalloyed copper is found, other methods must be employed in producing pure copper.

During the last four years the process has again been improved under patents granted to M. Paul David. In 1899, in the historically celebrated copper smelter at Eguilles, near Avignon (France), belonging to the Société des Cuivres de France, he succeeded in constructing a converter which differs entirely from the old form in being spherical and possessing a so-called "pocket" or extension near the mouth. In this "pocket" is to be found the main advantage of the David process, which is based upon the well-known fact that, in forcing the air through molten copper matte, the precious metals lose their sulphur first and sink to the bottom as alloys, at the same time taking with them the main impurities of the matte, such as lead, zinc, nickel, cobalt, arsenic, and antimony.

This "bottom" copper contains all the gold which might exist in the matte, silver, however, being only represented by about one-fifth of its total weight. In Eguilles this bottom copper is cast into anode plates and subjected to electrolysis. According to the old method, the impurities were found in the end product, i. e., in Bessemer copper, while now these impurities are to be found almost entirely in the so-called "bottom" copper. In copper which is to be refined by electrolysis, the impurities often necessitate the changing of the electrolysis baths at the cost of much time and money.

In drawing off the David bottom copper from the converter, one-eighth to one-tenth of the total copper output is allowed to flow through the pocket. The charge then remaining in the converter contains much matte, with from 85 to 90 per cent copper, which, after the drawing off of the bottom copper, is again subjected to the "blow" until 99 per cent copper is obtained, which is then cast into bars. The "converter" copper, which is very pure, is then melted and "poled" in order to reduce the oxides of copper which result from overblasting. This melting also has the effect of liberating all sulphur dioxide which may have become inclosed in the mass. A second advantage of the David converter is that by placing the tuyeres obliquely in the lining, the molten matter is given a hyperbolical rotation. This motion of the molten matte has three advantages, as follows:

I. The air is thoroughly distributed; hence a quicker oxidation is brought about.

II. A very small amount of the matte is thrown out of the converter during the blow.

III. There is more uniform corrosion of the lining through the formation of iron silicate slags.

Herein lies the explanation of the fact that the copper smelter in Eguilles, since the adoption of the "converter," has been able to reduce the cost of production 40 per cent.

Eguilles is the only place on the Continent where the so-called "pyritic smelting" is used. By "pyritic smelting" is to be understood the smelting of copper ores (without any previous roasting) direct in water-jacket furnaces. The same John Holloway, who in 1879 caused experiments to be made in connection with his work on the Bessemer process, found that in smelting copper ores which were rich in sulphur, very little coke fuel was needed, the greater part of the heat being produced by the burning of sulphur with the oxygen of the air to sulphur dioxide.

In Eguilles the work proceeds as follows: Richly sulphureted copper ores from Spain and Algiers are mixed with copper carbonates from the Département d'Hérault, and with native copper from Turkestan. This mixture is then brought into the water jacket (with a small amount of coke) and smelted until a matte containing about 25 per cent copper is obtained. This matte is then brought into a second water jacket, and further concentrated to a matte containing about 35 per cent copper, and from this last water jacket it is drawn off by means of a trough into the "converters," where it is blasted for 80 to 100 minutes, until copper of 99.4 per cent purity is obtained. The lining consists, as usual, of three-quarter part medium quartz sand with one-quarter clay, and being, therefore, acidic, it serves to reduce the iron contained in copper ores to a slag, which, having a smaller specific gravity, can be drawn off by properly turning the converter.

A Nest-Building Fish.

BY RANDOLPH I. GEARE.

It is doubtful whether protective mimicry among animals is better exemplified than in the case of the fish commonly known as the marbled angler of the Sargasso Sea (*Pterophryne histrio*). Owing to its peculiar structure, it is a poor swimmer, and it therefore spends most of its life moving slowly about on the bottom, among corals, seaweed, etc., which these fishes closely resemble in color and in outline. They cling, too, to the floating masses of sargassum weed with their pediculated fins, and the color-markings of the fish closely resemble the weed itself. Not only does the weed thus furnish a home for this species, but the fish actually constructs a nest from it and therein deposits its eggs. One of these nests, found in connection with the Hassler expedition in 1871, was described as consisting of a round mass of sargassum, about the size of two fists, rolled up together. To all appearances, it was made of nothing but this gulf-weed, the branches and leaves of which were, however, evidently knit together, and not merely tangled into a roundish mass; for, though some of the leaves and branches hung loose from the nest, it became at once visible that the bulk of the ball was held together by threads trending in every direction among the seaweed. By close observation it became apparent that this mass of seaweed was a *nest*, the central part of which was bound up in the form of a ball, with several loose branches extending in various directions, by means of which the whole was kept floating. On still closer examination the nest above described was found to be *full of eggs*, which were scattered throughout the mass.

Nature has thus afforded a safe asylum for these somewhat helpless fishes, whose cutaneous filaments, which are plentifully provided on the belly, around the mouth, and on the dorsal spines, so nearly resemble the weed itself that predaceous fishes doubtless fail to recognize the living animals, and thus the latter escape extermination.

The ground color of this fish is a pale yellow, and on this light background are darker irregular brownish bands, very much like the branched fronds of the sargassum weed itself, while along the edges of these darker bands, on the bands themselves, and also to a lesser extent upon the rest of the body, are little white specks of various sizes, on an average about the size of a pin's head. These markings, which are regarded by ichthyologists as having been developed in mimicry of the minute shells (*Spirorbis*) with which the sargassum weed is often covered, afford an additional means of protection to the marbled angler from its natural enemies, the larger fishes.

In the Medical World, Dr. Moses describes a novel method of removing a fish bone crosswise from the throat. The bone was too low to be reached by any forceps at hand, and the author recalled a method of procedure told him by an old doctor who had been taught by a boy, namely, to tie a string in the eye of a smooth button and have the patient swallow the button, edgewise of course, and draw the button back by the string. This was done and the bone was promptly dislodged.

Correspondence.

Atmospheric Disturbances.

To the Editor of the SCIENTIFIC AMERICAN:

Below are a few observations in regard to lightning and thunder, which may be of interest to some of your readers.

The distance to which thunder may be heard I find to depend very much on the altitude of the listener. On a somewhat isolated hill, about 500 feet above the general level, I have heard thunder from flashes which were twenty miles away. The flashes were occurring several minutes apart, so that I could see the flash and time its thunder before a second flash occurred. But once on the top of a mountain, about one-third of a mile high, and surrounded by peaks two and three times as high at from ten to twenty miles distant, I heard thunder when there was not a thunder cloud in sight. The pitch was like that of the deepest organ notes. Two hours later a thunder storm, rising from behind mile-high mountains, twenty miles to the south, broke over us.

Once a very long thunder cloud stretched across the sky to the south and southwest of Foochow city. The eastern end of this cloud was over the valley of the Min River; the west end was over mountains which separated the watershed of the Min from that of a tributary, the Yung-fu River. The cloud had evidently spent its greatest force, and the northern side of it was dissolving into the air, so that it did not have a sharply-defined edge, but gradually deepened from the thinnest vapor at the outer edge to the blue-black of the center of the storm. I just happened to see a short flash of lightning pass between the western end of the cloud and the distant mountains, and then the upper end of that flash darted swiftly back, horizontally along the face of that cloud almost to the eastern extremity, in a serpentine course, dividing and branching as it did so till it resembled the picture of a river on a map, or the veins of a leaf. I saw this repeated five or six times, and each time the first short flash seemed to descend from the cloud to the mountain, and then spread itself over the face of the cloud, the operation occupying at least one second, and, I rather think, two or three seconds. The distance was too great for the thunder to be heard.

I was astonished, for I had been taught that the passage of lightning is practically instantaneous, and that our eyes deceived us when we thought we saw a flash descend from a cloud to the earth. But there I saw a flash darting through a cloud, whose progress was no more difficult to follow than that of an arrow from a bow or a ball from a cannon. This was before the days of kodaks and snapshots; but I have often witnessed the same thing on a partial scale. I have also seen the lightning strike many times since then; and it always seemed to descend from the cloud, in a minute yet appreciable moment of time. My explanation is this: The whole cloud is charged with electricity, which can only discharge itself in successive portions thus: *A*, *B*, *C*, *D*, *E*, etc.; *A* going first, and then *B* following *A*, and *C* following *B* and so on, the process beginning, say, at the bottom of the cloud and extending from that point downward to the earth and upward through the clouds. The part of the flash between the cloud and the earth may consist of hundreds of separate discharges. I have seen a flash, striking the earth, lose for an instant its intense brightness, and then regain it again. I have also seen a flash first strike at one point, and then split in mid-air and finish at another point, the discharge being followed by a double report of thunder. This double report was due mainly to the fact that one point was more remote than the other, though both were less than a mile away.

But there is one thing that puzzles me. When the flashes are somewhat distant there is a long *peal* of thunder; but when the lightning strikes nearby, there is just one sharp *crash*, and little or no rumble following it.

I sometimes find in Chinese junk shops old steel wire, from wire cables, which within certain limits is more pliable than soft iron wire, and it retains this pliability though bent back and forth any number of times. But beyond this limit the wire has the rigidity of rather highly-tempered steel. How is this peculiar quality imparted to the wire?

J. E. WALKER.

Shao-wu, Fuchien, China, July 16, 1903.

An effort is being made in England to raise sufficient money for the erection of a memorial to John Kay, the inventor of the "fly shuttle." In every loom before his time, the shuttle was passed by hand through the warp from one side to the other. The invention about doubled the capacity of the operator, and the innovation aroused the ire of the weavers to such an extent that Kay was made the victim of a mob attack at one time, and his house and property destroyed. He died in poverty, and the location of his grave is unknown.