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.

Automobile News.

The bicycle police of Washington, D. C., have recently had Jones speedometers placed on the front forks of their wheels, and have been instructed to arrest no automobilists for excessive speeding unless, when following them, the speedometer shows that the legal limit is being surpassed. After an official test over a quarter-mile stretch, each instrument that is found to be accurate is sealed and officially numbered, and a record of it is kept for reference. So accurate are the instruments, that none of them has been found to vary more than a fraction of a second during the quarter-mile test at a rate of 15 miles an hour. Of the 72 bicycle policemen, 38 at present have speedometers. These are of a new type, one of which was illustrated and described in the SUPPLEMENT, No. 1440.

On September 17 the Oldsmobile runabout, driven by L. L. Whitman and E. T. Hammond across the continent from San Francisco, arrived in this city, having made the journey in 73 days, on but 57 of which runs were made. The time made by the runabout compares very favorably with that of 65 days, made by Dr. H. Nelson Jackson in a 20-horsepower Winton, and that of 61 days, made by E. T. Fetch in a 12-horsepower Packard, earlier in the season, especially when it is considered that the tourists had very rainy weather and were detained 9 days in Omaha because of a flood and 6 days elsewhere in Nebraska because of the rain and impassable roads. When they once got away from the rain they made very good time, and succeeded in traveling from Omaha, Neb., to New York in 11 days. The machine used was an ordinary 5-horsepower Oldsmobile with wire wheels, its weight being about 900 pounds. The tourists made the trip on their own account, and were not sent out by the company. The next aspirant for transcontinental honors is said to be Mr. H. H. Harkness, who, it is stated, will shortly attempt the trip in the reverse direction, on a powerful touring car of his own make.

This year's automobile endurance test, held under the auspices of the National Association of Automobile Manufacturers, will take place October 6 to 14, over a route 794¼ miles in length, from New York to Pittsburg, Pa., going *via* Kingston, Binghamton, Owego, Corning, Genesee, Buffalo, Erie, Cleveland and Youngstown. The test will be much more severe than the New York-Boston one of last year, and is calculated to show the endurance properties of the 1903 machines over all kinds of roads and grades one is liable to meet with when touring in the middle West. The rules governing the test are to be more rigid than ever before. Perfection in everything, including a hill-climbing and brake test at the end of the run (250 points each), entitles a car to 6,000 points, 3,000 of which are devoted to the run (with the usual one point per minute deduction for penalized stops), 1,000 to weight-carrying capacity, and 1,500 to the condition of the machine at the finish. Each automobile will be required to carry a load equal to 25 per cent of its weight. Instead of the observers traveling the whole journey on the machines to which they are assigned at the start, they will be changed to a different car every day, so that they will have no especial interest in any one car. The manufacturers have set themselves a most thorough test, and unless the weather is bad, the majority will doubtless come through it with flying colors.

The dangers of automobile racing on the track at speeds of 60 miles an hour and under have become quite apparent this month from the numerous accidents that have occurred. In several instances the spectators lining the fence have gotten the worst of it, the operators of the machines being but slightly injured, while in two cases at least the chauffeur has paid the penalty of his daring with his life. On September 3, while practising on a 25-horsepower Packard racer for the coming races on the Glenville track, at Cleveland, Charles Schmidt, by making a sudden swerve to avoid another machine, caused his car to slew and strike the fence, throwing him 20 feet into the inclosure and breaking three ribs. Two days later a new Baker torpedo electric racer had its front wheel taken off by another machine cutting across in front of it, and ran under the fence, injuring several spectators. At the Detroit races, September 9, Barney Oldfield, on the Winton "Bullet," ran off the track and through the fence owing to a tire bursting on the front wheel. A spectator sitting on the fence was killed, and Oldfield had a rib broken and was badly cut, though he kept his seat and was in the car when it finally brought up against a tree. Shortly after this accident, Harry Cunningham, on the Ford-Cooper car, had a similar one. He, too, plunged through the fence, shattering the front wheel of the machine, but fortunately himself escaping injury. September 12, at Milwaukee, Wis., the same car turned a somersault and fell on the chauffeur, Frank Day, killing him. This accident also, it is thought, was due to a tire bursting. At a county fair at Zanesville, Ohio, on September 9, Earl Kiser's racer burst a front tire, causing it to run into the fence and kill one man and injure six other persons besides the driver, who had his ankle broken. On the 17th instant, at St. Johnsbury, Vt., a machine being raced on a track at high speed, dashed off and over a 15-foot embankment, killing Herbert Lamphere, who was acting as mechanic, and very seriously injuring Dr. John H. Allen, who was driving it. All these accidents go to show how dangerous track racing has become, and they should serve as a warning to spectators to keep away from the fence.

Although Gen. Nelson A. Miles has reached the age when all army officers are placed on the retired list, he has shown himself to be still up-to-date and thoroughly conversant with the progress that is being made in automobile transportation in this country. Almost his last official act was the sending of a letter to the Secretary of War, in which he urges the replacement of five regiments of cavalry by a like number of men thoroughly trained and constantly employed in the use of the bicycle, motor-cycle, and automobile. The duties of these men would be those of reconnaissance, with the study of topographical conditions of the country, together with the surveying and mapping of it, as well as the repairing and building of roads and bridges in war times. The five regiments should be regarded as a flying corps and a corps of observation, to open the way for the advance of the army, and obtain all needful information. Officers and men of the cavalry, artillery, and infantry, and of the quartermaster's and medical departments and engineer and signal corps, should serve two or four years with this corps. In our army there are one-half as many cavalry as infantry regiments, while in European armies there are but one-fifth, and in the English army but one-seventh. This large preponderance of cavalry being useless and very expensive to maintain, it should be replaced by an up-to-date corps that would be of great service, not only to the military, but also to the people at large.

The army officers of nearly all the large foreign countries have spent considerable time during the last two years in experiments with the automobile for war purposes. Germany recently appropriated $70,000 for the purchase and maintenance of autos for her army, and at the October maneuvers this year, six of the newly-purchased machines will be used, one of them by Emperor William to direct his army. Six other machines are to be furnished for a thorough test also, by the patriotic German manufacturers. The French, who were the first to apply the automobile to war purposes, recently appropriated $4,000 more for automobiles.

Racing launches propelled by high-power gasoline automobile motors are now all the rage in France. In a recent race from Paris to Trouville *via* the river Seine and the North Sea, such a launch, fitted with a 35-horsepower Mercedes motor, covered the distance at an average speed of 22 knots an hour. Of the 28 launches which started, 25 were of the cruising type and 3 were racers. The number of launches that succeeded in covering the whole distance of 208 miles was 22. Though the sport of motor-launch racing was started and has received a great impetus this year on the other side of the Atlantic, yet the first high-powered boat of this type was designed and built in this country last year by H. S. Leighton, of Syracuse, N. Y. This launch is the "Adios," which has a total length on and above the waterline of 55 feet, with a beam of 7 feet, 9 inches, diminishing to 6½ feet on the waterline. She is driven by a 120-horsepower, eight-cylinder engine of the two-cycle type, connected to a single propeller, and she covered two accurately measured miles on Onondaga Lake last year at a speed of 23 miles an hour. The latest racing launch built in this country is the "Standard," which has a very light mahogany hull, 58 feet, 10 inches long, by 6 feet beam at the waterline, and 1 foot draught. She has a new type, 100-horsepower Standard motor, designed by E. A. Riotte, of the United States Long Distance Automobile Company. This motor is of the four-cycle type, has six cylinders, and runs at a speed of 400 R. P. M. A 41-inch propeller is used to drive the launch. In a race between these two boats over a course of 10½ nautical miles, the "Adios" was allowed a handicap of 3 minutes, 27 seconds, and she succeeded in beating the "Standard" by 12 minutes, 30 seconds, as the latter had to stop for 5 minutes on account of a pump overheating. The "Adios" covered the distance in the elapsed time of 34 minutes, 17 seconds, or the corrected time of 30 minutes, 60 seconds.

The Current Supplement.

In the current SUPPLEMENT, No. 1447, the first article is the conclusion of "The Mechanical Handling and Conveying of Coal and Coke," describing the most recent European practice. "The North Sea Fisheries," "German Engineering Impressions of the United States," "Eyes That See in the Dark," by Dr. Austin Flint, are all most interesting articles. "Aluminothermy" is a curious metallurgical process with special reference to welding. "Electricity and Matter" is a lecture by Dr. Oliver Lodge. "La Strobeika Persane" describes a mystifying trick. Engineering Notes, Trade Suggestions from United States Consuls, and Trade Notes and Recipes will be found in their usual places. The number is a most interesting one.

Engineering Notes.

The directors of the Great Western Railway Company are said to be considering the question of ordering two turbine steamers for their Irish service. They will not be required until the company remove their fleet from Milford Haven to Fishguard, where new docks are being built.

The coal-handling machinery installed at the Lincoln Wharf Power Station of the Boston Elevated Railroad Company recently lowered the world's record for rapid unloading. The coal was raised 90 feet above tide water and delivered to the storage pockets at the rate of 320 tons per hour. The installation follows in general design the standard Hunt steeple tower rig, the moving gear and coal cracker being electrically driven, and the hoisting engine direct connected. The overhang of the folding boom is 40 feet, and the capacity of the shovel two tons.

According to Prof. Richards, of the Lehigh University, the waste gases from a modern blast-furnace are capable of developing 10,000 horse power if utilized in suitable gas-engines. It is interesting to note in this connection that the great Niagara Falls Power Company, up to a few months ago, was only developing some 50,000 horse power by its turbines, and even now, the power available at three modern blast-furnaces would be capable of pumping back again all the water they use. The principal outstanding difficulty in utilizing these waste gases lies in the size of the scrubbers necessary to clean the gases before passing them into the engines. If they are not washed thoroughly free from tar, trouble arises from the gumming up of the valves.

At the half-yearly meeting of the shareholders of the London and North-Western Railway, Lord Stalbridge said the company built experimentally a number of 20-ton coal wagons, but they were objected to because they were too high to go under many of the colliery screens, too wide for the stallages at the collieries, and too heavy for the weighing machines. As the coal traders themselves did not seem disposed to alter the carrying capacity of their wagons, the company determined to continue experiments until it found the most suitable wagon to recommend for adoption by the traders, and it had built vehicles of a carrying capacity of 15 tons. Some of the advantages of these larger wagons to the traders were that they would carry roughly twice as much coal as the majority of their present trucks, while occupying only about the same space in the sidings, and the first cost was very little more than that of the smaller trucks.

The United States Consul-General at Coburg says that a type of oil engines has been invented which has attracted considerable favorable notice. The oil is vaporized and ignited without the use of any external source of heat. The main drawback has been that the engine would not run indefinitely with light loads, owing to the explosions not occurring with sufficient frequency to keep the igniting portion at a sufficiently high temperature. A modification of this type of motor just brought out by the Britannia Company, of Colchester, England, is claimed to be free from this drawback. The vaporizer is arranged, as usual, at the back of the cylinder. On the suction stroke a vapor valve is opened by the cam shaft, and through this valve air is drawn into the cylinder through the vaporizer, into which at the same time a little oil is sucked through an automatic valve. This mixture of air and oil is in itself too rich to be explosive, and the main supply of air is drawn through a separate air valve into the cylinder. Two passages connect the vapor valve with the cylinder. One of these is large and straight, while the other is narrow and U shaped. The lower portion of the U contains the igniter—a piece of metal having ribs, which enable it to absorb heat readily when the explosion takes place. This piece therefore becomes and remains red hot, while the rest of the vaporizer is only at a black heat. The vapor which is drawn through this igniter on the suction stroke is far too rich to burn, but on the compression stroke air is forced back into the igniting piece and provides the necessary oxygen for the vapor already there to ignite. None of the exhaust passes through the igniter, which is consequently not cooled down in the case of a missed explosion. The proportion of oil and gas used is regulated by throttling the air supply. As already stated, part of this air is drawn through the vaporizer and the rest through the air valve. If the admission to the latter is throttled, a greater proportion of the air used will be taken through the vaporizer and will carry with it a proportionately greater amount of oil. The makers claim that, once started, the engine will run absolutely without attention for several hours.