tions, and in the formation of nitric acid it is filled with coke. Through this the gases are slowly borne by means of an exhaust fan at the top of the tower, and are brought into contact with water, which trickles down through the coke. Nitric acid (HNO_3) is then formed by the following reactions when the gases are warm: $3\ N_2O_3 + H_2O = 2HNO_3 + 4NO$. The latter product unites immediately with oxygen as follows: $NO + O = NO_2$. This in turn unites with water and forms another portion of nitric acid: $2\ NO_2 + H_2O = HNO_3 + HNO_2$, while the latter product breaks up according to the following equation: $3\ HNO_2 = HNO_3 + 2\ NO + H_2O$. The two molecules of nitric oxide (NO) will then repeat the cycle, beginning at the second equation. If the gases are cold a more simple reaction takes place, and nitrous acid is formed as follows: $N_2O_3 + H_2O = 2\ HNO_2$. This, however, is a very unstable acid and at ordinary temperatures decomposes, as in the fourth equation above, to form nitric acid, nitric oxide and water.

In the production of fertilizer the gases are combined with lime to form calcium nitrate. This is a far better fertilizer than sodium nitrate or Chile saltpeter now on the market, first because there is danger of injury to plant life when the latter is used too freely, owing to the presence of soda, which burns the roots of the plants, and second because lime (which the soil needs) is liberated from the calcium nitrate, instead of soda, which is the result of the decomposition of nitrate of soda (which the soil does not need and which is positively injurious). The cost of producing calcium nitrate according to the process described is less than one-half the present cost of sodium nitrate. In their endeavor to reduce the cost of production to a minimum, Messrs. Bradley and Lovejoy found that the output of the machine is governed by the following three considerations: First, the amount of electric current, which as previously stated, gave the best results at between 0.001 and 0.01 ampere; second, rate of air current passing into the chamber, since too rapid a flow would result in the chemical combination of only a small portion of nitrogen and oxygen of the air, while too slow a flow would permit the gases to pass a second time under the influence of the arcs and dissociate the compounds previously formed; third, the amount of oxygen in the air, the best results being obtained when the gaseous mixture is composed of approximately equal portions of oxygen and nitrogen. Notwithstanding the fact that the machine is already a commercial success, experiments have not ceased. The inventors are thoroughly testing all details, and are busy working along new lines which are constantly presenting themselves.

The first Pacific third rail system was opened in August. The road extends between Riverside and Van Asselt, California, for a distance of about six miles. Throughout the trial run a speed of fifty miles an hour was made.

NEW YORK-BOSTON AUTOMOBILE RELIABILITY TEST —THE FIRST DAY'S TRIP.

Under a cloudless sky and in the bracing air of a fine October morning, seventy-five of the seventy-eight automobiles entered in the Reliability Test started north on Fifth Avenue from Fifty-ninth Street in this city at 9 o'clock, for New Haven, Conn. The vehicles began the journey at thirty-second intervals by the official timekeepers, stationed at Fifty-eighth Street, and soon formed quite a procession as far as the eye could reach. The operators and observers as a rule had their eyes protected by goggles, while many of the experienced chauffeurs were dressed in the typical dust, dirt and rain-proof black leather suits.

The route followed was north in Fifth, thence west to Seventh Avenue and via Jerome Avenue to Fordham, then east across to the Sound Shore Road, northeasterly into New Rochelle. From here the old Boston Post Road was followed through the various cities and towns to New Haven, Conn. The first forty-four miles to Norwalk, Conn., where the first control was stationed, were scheduled to be covered in three hours and ten minutes, which constituted an average speed of 14 miles per hour.

The Knox carriage, in which the writer and observer traveled, was one of three of that kind entered in the run. The novel feature of this machine, as illustrated and described in the SCIENTIFIC AMERICAN of March 1, 1902, is an eight horse power air-cooled motor which has numerous heat-radiating pins screwed into the outer wall of the cylinder, upon the head of which a fan, driven by a pulley on the two to one cam-shaft, is constantly blowing. The radiating surface is much greater than that obtained on motors of the flange air-cooled type, while the fan serves to keep the valves and valve springs reasonably cool.

MOUNTING BYRAM HILL, GREENWICH, CONN.--SIXTEEN PER CENT GRADE.

Starting among the foremost of the contestants, two of these machines kept together throughout the whole first day's journey, and all made a perfect record. Not a stop was recorded against them in either of the two stages, and the two that kept together were on time to the minute at the noon and night controls. No bad roads were met with during the entire day's run, though several bad hills were encountered in the vicinity of Greenwich and Norwalk, Conn. Our illustrations give an excellent idea of the train of automobiles mounting the long sixteen per cent grade at Byram Hill, in the town of Greenwich, and the way in which the vehicles were lined up for starting on the second half of the journey at Norwalk. The Knox machines climbed these without perceptible effort, and the low gear was not resorted to in any case till two-thirds of the hill had been traversed. One or two long and rather steep hills, where a good start was obtained, were ascended entirely on the high gear, without once throwing out or "jockeying" the clutch; and on the whole the Knox motor developed fully as much power as any water-cooled motor of its size, and an abundance for propelling its 1,300-pound carriage up the steepest grades. The many advantages and the simplicity of the new system are obvious, and need not be dwelt upon here.

LEAVING NORWALK, CONN.—THE FIRST CONTROL STATION.

By means of a table giving the times at which the different towns should be reached, it was possible to keep close to an average speed of fourteen miles an hour. It was difficult to hold to this speed, which seemed very slow on the smooth stretches of road, especially when many of the more eager contestants would now and then speed past. We were some minutes ahead of our schedule after passing through Stamford, Conn., and so, in company with many others, we were obliged to "lose time" during the last few miles, in order not to exceed our minimum time limit. We passed about a half dozen cars in trouble from punctured tires throughout the entire morning's run; but there were no genuine breakdowns noted, all the machines arriving at Norwalk. A Packard heavyweight car had a tire give

out a few yards before crossing the line at the noon control. Another car that had tire troubles was the huge locomotive racer of S. T. Davis, Jr. The locomobile gasoline touring car was driven by its designer, Mr. A. L. Riker, and reached both controls on time, without any mishaps. Three White steam stanhopes and two White delivery wagons arrived safely at the finish, and all the well-known firms, such as the Winton, Haynes-Apperson and Oldsmobile Company, were represented by two or more of their cars. Among the new machines that reached New Haven successfully were the Rambler, the Stevens, Duryea, the Fredonia, the Elmore (driven by a two-cycle engine) and the Autocar tonneau. A combination gasoline-electric car entered by Knight Keftel, owing to a defective water circulation in its gasoline engine, became overheated and did not reach Norwalk for three and a half hours after the others. The battery was kept charged en route by the gasoline motor and generator. The contesting carriages were mostly of the gasoline and steam types only. The first vehicle to reach the New Haven control was a De Dion run by Kenneth A. Skinner. Seventy-two vehicles out of seventy-five starting from New York reached New Haven. Each observer is provided with a specially-arranged note book having pages of sectional maps explaining the route and other pages for noting mishaps and delays that may occur. The contest began on Thursday morning, October 9th, and occupied three days from New York to Boston, resting there over Sunday. The return to New York was made on Monday, October 13th, taking three days and was concluded in New York on the 15th inst. The distance traveled was 488 miles.

Reports of the second day's run, October 10th, from New Haven, Conn., to Springfield, Mass, sixty-nine miles, state that out of seventy-three leaving New Haven seventy-one reached Springfield. The Knox machine, on which the writer rode, broke its crank shaft before reaching Hartford and a Haynes-Apperson machine in running rapidly into a sand ditch at one side of the road in avoiding a rear collision with preceding vehicles broke both front spring hangers, which caused the front of the body to fall on the gear, making a peculiar looking appearance. There were numerous brief delays to other vehicles caused by punctured tires or defective sparking plugs. The first to arrive at Springfield was a Packard, time from New Haven being 3 hours, 11 minutes, 45 seconds. In the evening a banquet was given the travelers by the Knox Vehicle Co. at the Cooley House, Springfield. The third day's run from Springfield to Boston on the 11th was successfully completed, sixty-nine machines reaching there on time.

The French Naval Department is constructing a new type of submarine boat, the invention of Lieut. Boulin, commander of the submarine "Triton." This craft is entirely different in its general design from all existing submarine war vessels, inasmuch as it is practically a submersible armorclad. The boat, which is of much greater dimensions than the present submarines, resembles a small cruiser, is propelled exclusively by steam power, and is replete with powerful quick-firing guns. When submerged it is not entirely obscured beneath the water, but the upper portion of its funnel is shown above water, and this, being painted gray, is visible only at short distances. To attack, the boat emerges from the water, launches its torpedo, discharges its guns, and again descends into the water, leaving only its funnel to be fired at, the water forming an excellent protection to the hull, which is built of chrome steel. This vessel is to be constructed at Cherbourg and will cost $400,000.

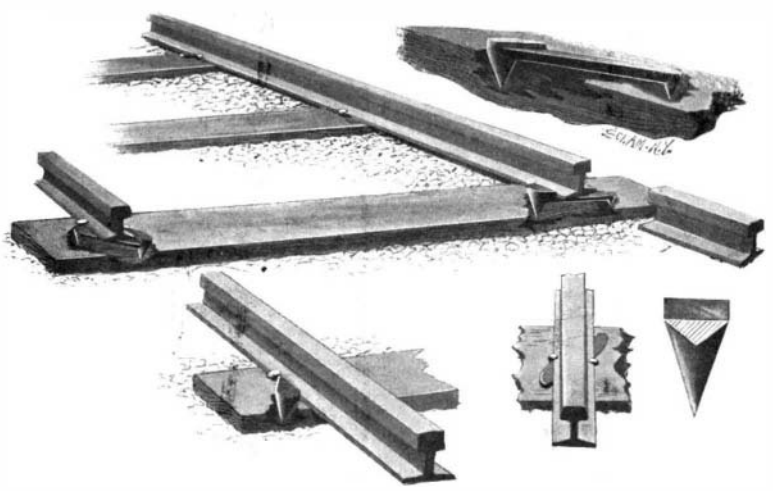
An attempt is being made in England to revise the standard of weights for commercial purposes. The suggestion is to create new weights of 50 pounds, 25 pounds, or 20 pounds, 10 pounds, and 5 pounds avoirdupois, respectively, to run concurrently with the hundredweight series of weights. The corn, cotton and tobacco trades have adopted the cental system, but it is necessary to make up the cental to use the 56-pound, the 28-pound, the 14-pound and the 21-pound weight. If two sets of weights are used, one based on the hundredweight and the other on the cental, confusion can be avoided by making the new weights, or otherwise plainly distinguishing between the two series of weights. This new system is averred to be imperative in order to accelerate and make British trade easier than it is with the antiquated system of hundredweights, quarters and pounds. The proposal is being enthusiastically supported and there seems every possibility of its coming into vogue.

The new balloon for Mr. Santos-Dumont, the construction of which has been begun, will be 25 meters long by 11 meters in diameter, and will carry two aeronauts and eight passengers.

IMPROVED RAIL-BEARING PLATE.

The increasing weight of our railway freight and passenger trains is presenting new difficulties to civil engineers. The mammoth locomotive of to-day is too heavy for the track construction of yesterday. New devices must be provided for securely holding the rails, for firmly spiking the rails to the ties, and above all for protecting the ties themselves against the crushing pressure to which they are subjected. Neglect in any of these particulars will result in the spreading of the rails and causing accidents of serious proportions. The truth of this statement is proved by the large number of railway accidents due to spreading rails; and, further, the patent records show that the attention of inventors has been, to an increasing degree, directed to the solution of these difficulties.

A device which is adapted to positively hold the rails against sidewise movement and to entirely prevent crushing of the ties has recently been invented by Capt. V. E. McBee, fourth vice-president of the Seaboard Air Line, residing at Norfolk, Va., and who as a civil engineer has had the advantage of a thorough and practical acquaintance with the construction and operation of railways. His invention, which is herewith illustrated, consists of a steel plate of general triangular cross-section, having a prong or spike projection at each end and a boss or heel on the upper surface for engaging the rail flange to prevent spreading. These rail-bearing plates are driven into the ties diagonally to the direction of the track, so as to combine as large a bearing surface as possible for the rail with the most economical use of metal. At the same time this diagonal disposition across the grain of the tie prevents displacement due to splitting of the wood; and the V-shaped under surface of the tie plate being embedded into the tie makes it noiseless and gives additional security against the spreading of the rails. In practice it is found best to alternate the positions of the tie-plate so that the heel or retaining lug abuts alternately against the inner and outer edges of the rail flanges. One of the serious objections to flat tie plates, now often employed, is their tendency to buckle under the heavy loads they are required to sustain, thus offering practically no protection to the ties, with the result that a large sum must be expended annually to renew ties which have been badly crushed. In this device, however, no buckling is possible, because of the heavy triangular cross-section of the bearing plate. These tie plates because of their simple construction may be very economically manufactured, and the initial expense of equipping a road with them is soon repaid by the increased life of the ties.



IMPROVED RAIL-BEARING PLATE.

Treatment of Roads with Gas Tar.

While roads in the United States have been treated with crude oil to lay the dust and render them compact, in Italy the same end has been attained by using gas tar, and the experiments which have been made seem to be quite successful. M. G. Rimini, the district engineer at Lugo, near Ravenna, has published an account of the application of gas tar to some sections of the public road in that locality. He uses it in two different places on the provincial route near Lugo, where the circulation is very active. The first portion treated measures 40 feet long and 10 feet wide and the second 750 feet long and 13 feet wide. In spite of the prolonged dryness, the results of this treatment have exceeded the expectations, and the surface of the road has become very hard and compact, so that it is difficult to pierce it. There is no dust, and the rainwater flows off without penetrating, and thus there is no mud formed. The color of the soil becomes that of a very dark sand. It is not necessary to treat the whole surface of the road, but only a band in the middle about 12 feet wide. As to the cost of the treatment it is estimated at only $96 per mile. M. Rimini is making observations of the two sections thus treated before applying it on a larger scale.

The Piscicelli Taeggi Electric Post.

News comes from abroad that the Italian government is considering a scheme for the transmission of mail matter by aerial electric railway at a speed of 250 miles an hour. The inventor, Signor Piscicelli Taeggi, has filed an application for a United States patent.

The aerial track over which the mail is to be transmitted consists of four wires which also act as conductors. The top wires will carry the motor or driving wheels, and two lower wires will support the wheels of the mail-boxes. High-tension three-phase current at 3,000 volts, stepped down to a potential of 260 volts, is to be fed to the two top wires and one of the lower wires, for supplying the motors of the mail boxes.

In order that one mail-box may not come within the block occupied by another mail-box, the step-down transformers will be located three or four miles apart. The preceding mail-box will cut off all current on the block immediately behind it. In order to attain this end the second or lower wire is used.

The supporting wheel of the mail-box in the preceding section having completed the circuit in the two lower wires, a current is allowed to pass through the magnetic coils of an automatic circuit-breaker, thereby shutting off the current from the section which it serves. When the mail-box enters the next section-head, the previously cutout section is again well supplied with current, and that immediately behind it rendered inoperative.

A mail-box traveling at the rate of 250 miles an hour acquires an enormous momentum. It therefore becomes a matter of considerable importance to devise means to cut down the speed. The inventor intends to cut off the section in advance of any station from any current by means of station switches, so that the momentum of the mail-boxes will be used only for a certain stretch. In addition, a braking device is employed. The mail-boxes are to be made of aluminium.

Signor Piscicelli Taeggi likewise has devised a system of collecting poles and boxes, as well as an apparatus for stamping the letters with the day, hour and minute of posting. Poles are also provided which act as transformer boxes, as well as supporters of the permanent way.

The letters can be dropped into receptacles, by which they are carried by an electric elevator to the top of the pole, where they are emptied into the mail-boxes.

In criticising this scheme, Mr. William Dig by in a recent number of Engineering says that although previous schemes of the same nature have not been altogether successful, nevertheless the remarkable advances made in electricity in recent years may be relied upon to overcome many of the difficulties which will naturally be encountered. He entertains grave doubts, however, whether the speed of 250 miles an hour can become an economic possibility, even if the difficulties of current collection at such speed should be overcome.

How long the aerial system would stand the strain of the mail-boxes' running at immense speed over the positions where the supporting and conducting wires are fixed, is a question that must give electrical engineers pause. Sparking and breakages of trolley wires at such points are among the minor troubles to be expected. When one remembers, too, how much of the vibration in railway trains is due to the spring of the rail ends at the fishplates, it will be recognized that any accentuated form of vibration along an aerial electric railway, with its saggings between insulator and insulator, would be fatal to its success.

The Current Supplement.

The current SUPPLEMENT, No. 1398, contains as its leading article a fully illustrated account of a novel electric power installation near Butte, Montana. Another electrical article describes the electrolytic manufacture of zinc. Just now the question of using oil as fuel is one that is uppermost in the minds of engineers. For that reason Mr. Edwin L. Orde's exhaustive paper on "Liquid Fuel for Steamships" will prove of unusual interest. Dr. Peter T. Austen, well known as a chemist of rare ability, writes interestingly of the chemical factor in human progress. The launch of the cruiser "Des Moines" is a subject that will appeal to our naval readers. Prof. Dewar terminates his scholarly "History of Cold and the Absolute Zero." The eruptions which have devastated Martinique and St. Vincent, as well as the telluric disturbances which have occurred in other parts of the world, render an article on volcanoes particularly timely.

Capt. Sverdrup, who returned from the Arctic regions soon after Lieut. Peary, narrates his experiences in search of the North Pole.

It is stated that the largest steel plate ever rolled was one recently turned out by the Parkgate Works, England; it is 30 feet long, 10 feet 6 inches wide and seven-eighths of an inch thick.