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The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

FUEL OIL IN THE MERCHANT MARINE.

Valuable information regarding the use of fuel oil on merchant steamships is contained in a report made by Lieut. Winchel on an investigation which he was ordered to make for the Navy Department of the efficiency of the oil-fuel plant fitted on the steamship "Mariposa" of the Oceanic Steamship Company of San Francisco, which trades between San Francisco and Tahiti. The "Mariposa" is a vessel of 3,160 tons. Her average indicated horse power, as shown on the trip under investigation, was about 2,491, and the mean speed was 13.53 knots an hour. The consumption of oil was 278 barrels per day, the average consumption of oil being 3,720 pounds per hour, which works out as 1½ pounds of oil per horse power per hour. Although in some of the most carefully designed and operated plants on shore, engines have been operated at as low a rate as 1½ pounds of coal per horse power hour, the consumption is practically 50 per cent less in weight of fuel than would be required with triple-expansion engines of the type installed on the "Mariposa" if coal were being used. In addition to the saving in dead weight carried, there was a great economy in the working force required, the engine and boiler room staff being reduced from 36 to 20 men. The boilers of the "Mariposa" contain altogether eighteen furnaces, and of these only twelve were used. There are two burners to each furnace; but it was only for short periods of time, when the engines were run at full power, that all the burners were in use.

The economy in fuel realized in these trials is not so marked as the economy in labor; for even on a vessel run under such high pressure as the "Deutschland" of the Hamburg-American Line, which has crossed the Atlantic at an average speed of 23.5 knots an hour, the consumption of ordinary steam coal is only 1½ pounds per horse power per hour, including auxiliaries; and on the vessels of the Inch Line, trading on the east coast of England, which use every refinement in the way of economizers, superheaters, etc., a consumption of a fraction under one pound of coal per hour has been realized. But it is in the economy of labor and space, and in the convenience of stowage, that oil fuel will have its greatest attraction for shipowners. Great as are these advantages for the merchant service, they are even more valuable for the navy, since the decrease in weight and bulk of fuel, and the possibility of stowing it in the double bottom, will place practically all of the space now used for bunkers at the service of the naval architect. Moreover, the diminished number of the crew will mean diminished requirements of weight and space for their accommodation. The saving thus effected can be given to an increase of armor or guns, or engine power, according as the architect wishes to develop either of these features in his vessel.

IMPORTANT SPEED TESTS OF STEAM AND ELECTRIC TRAINS.

The most direct evidence thus far afforded that the New York Central Railroad is taking active steps toward the installation of electric traction for its suburban service in this city, is a series of tests which have recently been carried out on the experimental track of the General Electric Company at Schenectady. These tests were made with a view to determining the relative efficiency of steam and electric traction in such suburban passenger service as is carried on by the New York Central Company. The primary object of the test was to make a comparison of the rate of acceleration of the same train when hauled by a New York Central suburban engine and by a pair of electric motor cars, such as would be used were the suburban lines to be equipped with third-rail electric traction. For the purpose of the test, a train of six cars was made up, which included five standard passenger coaches of the New York Central Railroad preceded by a dynamometer car. The engine selected was one of the big tank engines especially designed for the suburban service of the New York Central Railroad, the engine being provided for this purpose with large heating surface and cylinder capacity and small-diameter six-coupled drivers. These engines have a total weight of 214,000 pounds, of which 128,000 pounds is on the drivers; a total heating surface of 24,065 square feet; cylinders 20 x 24 inches; a boiler pressure of 200 pounds to the square inch and a tractive power of 25,900 pounds. They have proved very successful, the acceleration being unusually rapid. Indeed, for this class of work, where stops are frequent, they are probably the best engines of their kind in this country to-day, and hence admirably adapted for a comparative test of capacity of acceleration with electric motor cars. For the electric test two General Electric motor cars, one weighing 73,000 pounds and the other 70,000 pounds, were used. These cars are 54 feet over all in length, and are equipped with four "G E 55" motors, all axles being provided with motors and the two cars together giving about the same weight on drivers as the steam locomotive. The test was, therefore, perfectly fair, the acceleration being directly comparable for trains of equal weight. The drawbar pull, speed and time were recorded by the same dynamometer car in all cases, the engine simply being unhitched and the two motor cars coupled up for the alternate trials. In carrying out the tests, the train of six cars with its engine or its electric motors, as the case might be, was started from rest and run over one mile of track, the acceleration being made as rapidly as possible with the power available. These runs were repeated, dropping off one car at a time, and a careful record was kept of the speed attained in 10 seconds, 20 seconds, 30 seconds, etc. The New York Central coaches weighed each from 48,200 pounds to 60,250 pounds, and the total weight of the train behind the engine or electric cars varied from 157 tons down to 23 tons.

The full data of this most valuable experiment were given in a paper by E. J. Arnold and W. B. Potter, at the last annual convention of the American Institute of Electrical Engineers, the complete text of which will be found in the current issue of the SUPPLEMENT. The electric runs were made upon the General Electric Company's experimental track against a head wind of 15 miles an hour. In the middle of the run there was a 6½ degree curve, the frictional effect of which was assumed as equivalent to the 1-10 per cent upgrade of the steam runs, which were made on the New York Central main line adjoining the electric works. In the case of the steam runs there was also a head wind of 15 miles per hour. Although the locomotive was especially built for rapid acceleration, having a large firebox and heating surface, the pressure dropped from 200 pounds at the commencement of the mile to less than 185 pounds during the early part of the acceleration. In starting, the throttle was opened wide and steam was used for the full stroke, the engine being hooked up as acceleration proceeded. In neither case was there any slipping of the driving wheels. Although the steam locomotive was able to exert a tractive effort at starting equal to that obtained by the electric motor cars, this high tractive effort was not maintained, but fell immediately with the increase of speed, in spite of the most expert handling of the throttle and reversing lever. The accelerations attained in each case at the end of each 10 seconds were as follows: With a train of six cars, the acceleration at the end of ten seconds was, for the locomotive, 19.5 miles per hour; for the motor cars, 11.2 miles an hour; at the end of twenty seconds, the speed had risen to 16.3 miles per hour for the locomotive and 21.2 miles per hour for the motor cars, the respective figures at the end of thirty seconds being 20.8 miles an hour for the locomotive and 28.1 miles per hour for the motor cars. With four cars only in the train the accelerations were in ten seconds for the locomotive, 12 miles per hour; for the motor cars, 14.4 miles per hour; in twenty seconds, for the locomotive, 19.5 miles per hour; for the motor cars, 27.4 miles per hour; while in thirty seconds the acceleration was, for the locomotive, 24.7 miles per hour, and for the motor cars, 32.4 miles per hour. With only one car attached, the accelerations were in ten seconds for the locomotive, 14 miles per hour; for the motor cars, 22.5 miles per hour; in twenty seconds, for the locomotive, 25 miles per hour, and for the motor cars, 34 miles per hour. In thirty seconds the acceleration for the locomotive was 31.7 miles per hour, and for the motor cars, 38.2 mlies per hour.

The comparison of results proves that the electric motors can better utilize the weight upon their drivers during acceleration than a steam locomotive, the motor covering the same distance in the same time with less energy expended and at less maximum speed than a steam locomotive, owing to its being able to maintain its maximum accelerating rate for a longer period. In making the tests the power was kept on until the three-quarter-mile post was reached, when it was shut off and the brakes were applied so as to bring the train to rest as near the mile post as practicable. The steam train ran from 5 to 15 per cent over a mile before the train was brought to rest, and the electric train from 2 to 4 per cent; but, in spite of the longer distance covered, the average speed of the steam runs only approached that attained in the electrical runs over a shorter distance. Since the electrical runs all show a lower maximum speed and a higher average speed than those made with the steam locomotive, the energy consumption of the electric runs should, therefore, be less for the same work done than with the steam locomotive. Since the motors of electric trains may be placed upon the trucks of ordinary passenger coaches, there is a saving of weight due to the elimination of the locomotive and tender, and the authors of the paper point out that, hence, the true basis of comparison between steam and electrically propelled trains should be the energy per seat mile rather than per ton mile. As an illustration of the advantages, in point of economy of power, of electrical traction over steam, a table based upon these tests is given in the paper, showing the energy required per passenger for both steam and electric runs; and from this we find that for a train of six cars the watt hours per passenger required in a steam train are 43.9, as against 29.7 in an electric train. In a three-car train the watt hours for steam would be 77.4, as against 37.5 for electricity. In a comparison of coal consumption, based upon the actual service of a steam locomotive for twenty-four hours covering four trips between North White Plains and the Grand Central Station on the New York Central road, it was found that the coal consumed per effective horse power hour was 15.6 pounds. In comparing this with electrical traction, it is assumed that the ratio of effective horse power output of motors to the indicated horse power of the central station engine is about 50 per cent. The average coal consumption per horse power hour at the electric power stations is assumed at 2½ pounds, and at this figure the coal per effective horse power output at the electric motors would be 5 pounds. Assuming the head air resistance as 10 per cent and the increased weight of the cars due to their electrical equipment as 20 per cent, the actual comparison of coal consumption works out in the ratio of 6.6 pounds per horse power hour for electric traction and 15.6 pounds for steam traction. Assuming the cost of coal for electrical power is about a third the total cost of that power if maintenance and interest on investment be included, it is concluded that the actual gross cost of electrical power would closely approximate the coal consumption cost of the steam locomotive in this class of service, the maintenance and attendance cost of the electrical equipment being, however, considerably in favor of electrical power.

THE COLLAPSE OF THE CAMPANILE—THE CAUSE.

In the October issue of the Building Monthly of the SCIENTIFIC AMERICAN will be found an article from the pen of an American, resident in Venice, on the fall of the famous Campanile. Accounts of official neglect have found a place in the daily papers; but it is doubtful if many suspected how culpable the authorities of Venice have been. Commendatore Giacomo Boni, known the world over for his work in the Roman Forum, furnished the writer of the article in question with a mass of information which shows how keenly alive certain architects were to the critical condition of the tower, and how willfully indifferent Italian officials apparently were to the fate of one of their grandest architectural structures.

As far back as 1878 the Italian architect Luigi Vendrasco foresaw the collapse of the old bell-tower and persistently tried to prevent it. His endeavors to save the Campanile ruined his career. It was while directing some work in the palace of the Doges that Vendrasco discovered how great the danger was. Although the fate of the Campanile was no official concern of his, yet he felt it his duty to warn the Syndic, the Prefect, and the various commissions charged with the preservation of architectural relics. Vendrasco's reports were never opened. He appealed to Queen Margherita and even to Queen Victoria. For that last bit of pertinacity he was officially requested to remember that he was an Italian and not an Englishman. Although repeatedly snubbed, Vendrasco still persisted in calling to the attention of the authorities the imminent ruin of the tower. In order to put an end to his letters, the troublesome architect was transferred to Cagliari. His advanced years prevented him from reporting in time to resume his new duties, for which failure he was dismissed.

Day by day Vendrasco saw the disaster approaching. When a cut was made in the east wall of the Campanile in repairing the roof of the Loggetta, Vendrasco saw that a fatal injury had been done. The cut reopened the old fissure of 1745, caused by lightning. Even some of the official engineers and architects now began to show concern; yet so general was the indifference of the Venetians that no steps were taken to avert a catastrophe. On the very day that the Campanile fell, the unheeded Vendrasco wrote, "The Campanile has but a few hours to stand." Hardly was the ink dry on his paper when the tower fell, crushing in the north end of the Library, almost miraculously sparing the great church and the neighboring magnificent structures that constitute the glory of Venice.

The causes of the collapse of the Campanile are fully discussed in the Building Monthly's article. The fissure opened by the stroke of lightning in 1745 was but indifferently repaired. Telluric movements and electric discharges continually disturbed the injured section. Still another element of weakness was the complete deterioration of the mortar which held the masonry together. Much of this mortar had so far crumbled away as to appear in the ruins like a fine white powder or dust. It had long lost all power of cohesion. Although the mortar had crumbled and become worthless, the bricks in the main were in good condition and showed astonishing hardness. Many were very old, far antedating the building of the Campanile itself. One bore an imperial stamp of the reign of Antoninus Pius; others showed prints of the feet of domestic animals and fowls that had walked upon them before they were burnt. The bricks ranged in age from the first century B. C. to mediæval times. The older ones had been taken from Roman edifices at Aguileia.

Though doomed largely through early official neglect of warnings received, the immediate causes of the collapse of the giant tower were the bungling repairs of the roof of the Loggetta. Here it was that the deep cut previously referred to was made into the base of the part of modern construction. The old fissure reopened, the crevice spreading with alarming rapidity. Even though this condition of affairs was brought to the notice of the city authorities, several days elapsed before concern was shown; visitors were even permitted to ascend to the belfry before steps were taken to preserve the structure. No adequate protection was given to the public on the Piazza up to within half an hour before the crash. One official ascended the belfry five hours before the downfall, and workmen, scaling a ladder resting against the tower-wall, saw the yawning gap spread over the wall ere they fled. A few moments later all that was left of the Campanile was a mass of ruins where the ladder had stood.

A new Campanile will take the place of the old on the Piazza San Marco. Subscriptions are pouring in from all parts of the world. Commendatóre Boni declares that work on the new structure will be commenced in the spring. That the new bell tower will not have the same associations with the historic past of Venice goes almost without saying. No traditions will lend their glamor to the modern structure; nor will the old poetic atmosphere cling to the new Loggetta which is to take the place of the ruined masterpiece of Sansovino. What may be styled the tombstone of the old Campanile will be erected on an artificial mound in the public gardens in Venice. This memorial will be a pyramid thirty feet high, formed of perfect bricks of the old belfry, and is to commemorate the great collapse of July 14, 1902.

PROTECTING OUR WILD ANIMALS.

BY GEORGE ETHELBERT WALSH.

One of the problems of the day which all lovers of animals and birds are intensely interested in is the successful adoption of some adequate methods of preserving the native wild animals and birds that are threatened with extinction by thoughtless and ruthless hunters and ignorant people generally. The fauna of the North American continent was the largest and most varied of any in the world in the days of the earliest settlers; but a century of steady destruction of the finest specimens of the animals brings us to-day to a realizing sense that, if we wish to have any of these creatures among us in the wild state, systematic efforts must be made to protect them.

In recent years the general movement to protect our song and plumage birds from ruthless destruction has resulted in educating the public to a higher appreciation of the value of these harmless creatures. Most States have enacted laws now which amply protect the birds. In the interests of sport our game birds and animals have likewise received partial protection during the breeding seasons when the rate of destruction is the greatest. Consequently these innocent creatures are in no immediate danger of extinction. In fact, they are actually on the increase in those States where the bird and game laws are rigidly enforced. All that the small animals and birds needed was such protection from man's destructive tendencies in order to enable them to breed and live in the woods and fields. With a little more general protection, we may hopefully look forward to the time in the near future when our song birds will be as numerous as ever.

But there is a class of animals and birds which cannot be reached by the ordinary methods of State legislation. The larger animals of the forest will not thrive well in captivity, no matter how the parks and zoological gardens may be arranged, and if kept confined they lose their native characteristics and degenerate in spirit and size. Gradually their extinction is inevitable. Legislatures may pass laws annually to protect them, but if they are deprived of their great natural habitats—the wild woods and forests—they will inevitably decline in numbers and die out. Their danger is not only from the hunter's rifle, but from the influences of civilization which are destructive to their existence.

So generally accepted is this fact to-day that efforts have been made in different parts of the country to protect the wild animals on large natural preserves where they can have all the freedom and comfort of a wild existence. In the great Yellowstone Park the national government possesses a vast empire of natural wilderness where all of the American birds and animals thrive in the most satisfactory manner. Although the government officers in the park have not been able to quell poaching and hunting entirely, they have succeeded in giving to the few wild buffaloes, deer and antelope comparatively ample protection. The domain is so large, and the temptation so great for unscrupulous hunters to enter the park for unlawful purposes, that infractions of the law are quite common; but under more stringent enforcement of present laws it may be possible to preserve indefinitely in the Yellowstone Park animals and birds that will be exterminated in almost all other parts of the country.

Recently there has been started a movement by the government to preserve the great forest reservations of the West from the destructive influences of hunters, settlers and woodmen. There are some 47,000,000 acres of these forests in the West which are under the control of the national government. Some of the woods have already been denuded of trees so that they would be of little value for preserving game; but most of them are almost as wild and unexplored as half a century ago.

That they will be preserved in part at least is now quite evident. The Forestry Bureau is making elaborate plans for protecting them from fires and the woodman's ax; but closely associated with their protection is that of the wild animals which roam through them. It is claimed by the experts that, if all game, whether of birds or animals, were protected in these great natural forest preserves of the national government, within another half century our fauna would be once more the finest in the world. These vast tracts of forest lands are the natural haunt of wild animals which refuse to breed and multiply in any small preserve or park. The freedom of the pathless woods seems necessary for their growth and happiness.

In view of the rapid denudation of our forests, and the destruction of nearly all the larger wild animals of the country the national government will soon be called upon to extend this protection to the hunted creatures which have been driven before the hunter's rifle to the most inaccessible recesses of the Northwest and Canada. Indeed the latter country has to-day become an asylum for many of our finest animals, and hunters annually seek them in this far country. There are parts of Canada which have never yet been explored, and in the limitless woods and forests north of us the wild creatures find the protection which nature gives them. Even a large remnant of our wild buffaloes have crossed the Canadian border and now feed somewhere in the loneliest parts of that country.

The protection of the birds and animals on the government forest preserves is one of the steps demanded to-day in the interest of science and humanity. In such places they would perpetuate their species far into the future. As matters stand to-day there are whole families and groups of wild animals which must soon become extinct if no provision is made for their protection in great natural forest preserves.

One of the greatest enemies to the wild animals in any woods or forest is fire. In the great Northwestern forests where fires annually consume thousands of acres of timberland small and wild animals are destroyed in such numbers that their race has become almost extinct. Unless there is water near at hand the animals are caught by the fire and killed. This destruction is peculiarly great in the fall of the year when the young creatures are just beginning to run around and enjoy themselves. They are unable to run a race with the fire, and eventually they are smothered to death or roasted alive. The question of preventing fires in the woods is one that lumbermen have considered carefully for years, but it is a matter that should appeal to the humanitarian as well as the utilitarian. Where there is one lumber mill or home of a settler burnt down by these fires there are ten thousand helpless animals and birds consumed in the fierce flames. Even on the government forest preserves these fires do a great amount of annual damage. Their prevention must be effected before either the forests or the wild animals can be preserved. As most of the fires start through the carelessness of railroads, hunters and settlers, it is possible to enforce regulations and punishments that would gradually tend to abate them.

In addition to the present movement to interest the national government in the work of preserving birds and animals on the natural forest reserves of the West there is a pretty general effort on the part of private individuals to establish preserves for breeding and protecting the wild creatures that stand now in danger of extinction. Some of these private preserves have been established simply in the interests of science and humanity. Their owners have created for the animals a natural asylum where they can live and enjoy themselves. They are not thus protected for the sportsman or hunter, but to keep them from extermination so that in the future there will be fine specimens of their race to gladden the hearts of generations yet to come.

SCIENCE NOTES.

Prof. A. E. Wright, of the Army Medical School at Netley, has published the results obtained by anti-typhoid inoculation. It is demonstrated, so it is said, that fewer cases and fewer deaths occurred among those inoculated than among those untreated.

Prof. Lucien M. Underwood, of Columbia University, and Dr. N. L. Britton, of the New York Botanical Gardens, as well as other scientists, have been investigating the flora of this State, and have discovered a new plant, or rather a new variety of an old plant. Near the salt beds of Syracuse, N. Y., they found specimens of the *Cissa marina*, which by no means conformed to the well-known species. The new form has been named *Cissa marina Syracusana*.

For twenty-five years the indefatigable Catholic priest, Father Delattre, has been engaged in archæological researches on the site of ancient Carthage, and now reports what he declares the best find made during this period. It is a white marble sarcophagus, 2.09 meters in length, partially covered with designs, that on the lid being a relief portrait of a woman, of rare artistic beauty. The sarcophagus belongs to the Punic period and is the work of a Greek artist. It is now regarded as the pièce de résistance in the well-stocked museum of the Pères Blancs in Carthage. The find was made in the necropolis near Ste. Monique.

The collection of physical apparatus which was left by the late George M. Hopkins has been given by his widow to the Adelphi College, of Brooklyn, New York, with a few exceptions, notably his optical lantern with its various attachments, with which he performed interesting experiments on the rare occasions when he could be induced to give public lectures. This has been given to his friend, Prof. W. LeConte Stevens, Washington and Lee University, Lexington, Va. The collection embraces most of the pieces of apparatus which are illustrated in "Experimental Science." The apparatus for the Adelphi College was selected from the collection by Prof. W. C. Peckham.

Victims of pulmonary complaints have heretofore been compelled to make inconvenient journeys to the higher altitudes in search of the pure rarefied air which is known to be so beneficial to them, but this is no longer necessary. It has been discovered that the air from limestone caves has all the characteristics of that of the mountains. This discovery has just been made use of in the location of a sanitarium near one of these caves, and the air for the institution is supplied from the underground caverns. This establishment is at Luray, Va., and the system of ventilation is arranged so that each room gets its own supply direct from the cave. The air of these caverns is of a very uniform temperature and remarkably pure and free from all germs and dust particles. In the warmest weather the doors and windows of this institution are kept closed, and a comfortable temperature of 75 degrees is maintained in spite of one of 90 or more encountered outside.

The Agricultural Department has begun a series of exhaustive investigations into the matter of cold storage. There are a number of mysterious manifestations which take place in a cold storage warehouse, and the government agents are endeavoring to ascertain the why and wherefore of these. For instance, it has been often noted that one lot of fruit will keep in fine condition for many months, while another immediately near will rot in a comparatively few days. This is particularly true of peaches. It has also been noticed that some peaches lose their delicate flavor very quickly in cold storage, while others are not affected in the least. In order to get at the facts, an agent of the Agricultural Department has been assigned to take a specimen carload at Fort Valley, Ga., and to make careful observation of the manner of picking and packing and to follow the fruit through the various stages through which it must pass on its way to a cold storage plant in Jersey City. Here the fruit will be watched carefully during its prolonged stay by the same agent, who will make a detailed report of his observations. The same programme will be carried out with other shipments of peaches as well as other fruit.