SCIENTIFIC AMERICAN

ESTABLISHED 1845

MUNN & CO. - - Editors and Proprietors

Published Weekly at

No. 361 Broadway, New York

TERMS TO SUBSCRIBERS

One copy, one year, for the United States, Canada, or Mexico.........$3.00
One copy, one year, to any foreign country, postage prepaid, £0 16s. 5d. 4.00

THE SCIENTIFIC AMERICAN PUBLICATIONS

Scientific American (Established 1845) ....$3.00 a year
Scientific American Supplement (Established 1876)............... 5.00 "
American Homes and Gardens....................................... 3.00 "
Scientific American Export Edition (Established 1878)........... 3.00 "
The combined subscription rates and rates to foreign countries will be furnished upon application.
Remit by postal or express money order, or by bank draft or check.
MUNN & CO., 361 Broadway, New York.

NEW YORK, SATURDAY, MARCH 2, 1907.

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.

RISKS OF STEEL-CONCRETE CONSTRUCTION.

A serious risk, which is none the less threatening because it is altogether unnecessary and preventable, exists in the new system of concrete-steel construction which is entering so largely into modern work. Its cheapness, its apparent simplicity of design, the ease with which its materials may be assembled and the speed with which they can be thrown together into the finished work, have combined to render this new form of construction extremely popular. The peril lies in the supposed simplicity of the design and in the ease and speed with which concrete-steel structures can be built. To these two causes chiefly, and generally to the latter, may be assigned the failures of concrete buildings, which of late have become alarmingly frequent

Let it be understood then, in the first place, that it is not a simple matter to properly design the posts, beams, girders, and floors of a concrete building; that is, to design them so as to secure a maximum amount of strength with a minimum amount of material. It is not nearly so simple a matter as to design a building composed of a structural steel skeleton, with tile, concrete, or masonry floors and walls. Concrete-steel construction, in the present state of the art, is scarcely out of its infancy. In spite of the fact that it has been made the subject of much laboratory and testing yard experiment, the sum total of clearly ascertained and reliable data is not large. So true is this that there are few classes of work that come within the engineer's or architect's province, in which he is called upon to exercise such excellent judgment and to apply so carefully the facts and principles of his profession, as in concrete-steel construction. However, it is not here that the chief peril lies; not at least when reputable engineers of standing in their profession are employed. It is when the plans are handed over to the builder with his gangs of cheap labor that the trouble begins. For unless the foreman or assistants, whose duty it is to watch the actual laying and ramming of the concrete, are careful and intelligent in their oversight, it is possible for the work to be so carelessly done as to greatly impair its strength, if not to make certain its ultimate collapse. The steel bars which reinforce what might be called the lower chord of a concrete girder, or the exterior shell of a column, lose their value unless the concrete is everywhere so snugly rammed against them, as to throw them into intimate stress relation with the girder or column as a whole. "Eternal vigilance" should be the watchword of the future, if this new form of construction is to regain the reputation for combined cheapness and strength, which has been so severely imperiled by the many failures of the past few months.

SHOULD SURFACE SOIL BE STRIPPED FROM RESERVOIRS?

In connection with the plans of the new Catskill reservoirs by the New York Board of Water Supply, the question arose as to whether it would be advisable to strip the surface of the ground which will form the bed of the big Ashokan reservoir of all vegetation and surface soil, with a view to securing a better quality of water. The practice of stripping is advocated by the hydraulic engineers of Massachusetts, and the most notable instance of carrying out this costly method of securing pure water is to be found at the Wachusets reservoir, which impounds over 60 billion gallons of water and forms the main source of the Boston water supply. The new Ashokan reservoir will have a capacity of 140 billion gallons; and the New York Board of Water Supply, having in view the great expenditure which would be necessary to strip the bed of the reservoir, referred the whole question to a board of two engineers, who have lately presented an exhaustive report, in which it is shown that while there are undoubted advantages in the practice of stripping, a more effective method of purification is to be found in the construction of filtration plants, through which all the water must pass in its course from the reservoirs to the city's faucets. Moreover, in spite of the most careful safeguards, it has proved to be impossible to absolutely prevent infection of the watersheds from which reservoirs are filled, and it has come to be recognized that the only effective way to attack the problem is by interposing a filtration plant between the open-air reservoirs and the city to be served, which will not only remove all bacteriological impurities, but also those which are due to submerged and decaying vegetation.

THE "MIKASA" WAS SUNK BY SPONTANEOUS MAGAZINE EXPLOSION.

The loss of Admiral Togo's flagship "Mikasa," as the result of an internal explosion, was one of the most startling events of the Japanese war; and the tragical atmosphere which surrounded the catastrophe was deepened by the fact that the "Mikasa" was more strongly associated in the minds of the Japanese people with the triumphs of the war than any other ship in their navy. Moreover, there was a sinister rumor, rather industriously circulated, that the loss of the ship was the work of discontented Japanese sailors. To at once clear the navy of any such imputation, and solve the mystery of her loss, the Japanese Admiralty made an immediate investigation by means of divers, who reported that no trace could be found of misconduct or neglect on the part of the officers or men, the explosion having originated in the port magazine containing 6-inch ammunition. When the vessel was recently refloated, the Naval Department appointed another committee, whose investigations have shown that the explosion resulted from spontaneous combustion, due to a chemical change in the ammunition of the 6-inch magazine. That smokeless powder has always been, and, in some of its forms, is yet, liable to dangerous decomposition while in storage, is well known, and it is more than likely that other serious warship explosions and disasters may have been due to this sinister and at one time greatly-dreaded cause.

THE PERIL OF THE ELECTRIC LOCOMOTIVE ON STEAM ROADS.

In asserting that unless special precautions are taken the introduction of electric locomotives on steam roads is fraught with great peril, we wish to make it clear that the statement is applied to the electrification of steam railroads in general, in whatever part of the world the change of power may be taking place. We have no wish to cast any special reflection upon the railroad upon whose tracks occurred the shocking derailment disaster of last week. Indeed, considerations of fair play should lead us to bear in mind that the very roadbed on which the accident took place represents the most advanced ideas in track construction in America, and for that matter, in the world. It consists of 100-pound rail with tie plates between rail-base and ties, and from 12 to 18 inches of broken stone ballast laid upon a well-drained foundation. That the track was well adapted to its work of carrying heavy, high-speed steam trains is shown by the fact that some of the fastest trains in the world, drawn by the heaviest express locomotives in existence, have for years been running daily over the particular curve where this accident occurred, without any trouble whatever. Some of these expresses are made up of nine cars, weighing over 500 tons, and hauled by an engine that weighs about 170 tons. Yet, on the present occasion, although the train was a light one, consisting of five cars of about 200 tons combined weight, hauled by two locomotives weighing together 190 tons, the outer rail was pushed bodily aside, and the train back of the engines derailed.

Evidently there existed in the ill-fated train some novel conditions which were sufficient to cause the wreck, and one does not have to look very closely into the matter to find ample evidence that the new conditions were to be found in the heavy concentrated weight and low center of gravity of the electric locomotives, and the enormous horse-power, between 6,000 and 7,000, which the motorman had at command. It is our belief that this disaster should call an immediate halt upon the application of heavy electric locomotives to steam roads, until the tracks at all curves have been put into a condition to meet the heavier stresses which will be imposed by the higher speed, the concentrated wheel loads, the rigid wheel base, and the very low center of gravity of the electric locomotives. The express steam locomotives of the New York Central Railroad have a maximum horse-power of about 1,700, whereas the electric locomotives of the same road have developed a maximum of over 3,000 horse-power. Of course, it is not intended that this maximum shall be used, except in emergency cases in which unusually heavy loads must be hauled at the highest speed. Yet it will inevitably occur in future electric operation, that an engineer will occasionally be behind time during a trip on which he has a light train behind his powerful motor, and he would not be human if he did not feel the strongest inducement, having such an enormous reserve power at his command, to open his controller and make up, as he could easily do, the lost time. But at these excessive speeds (and they will inevitably be made, in spite of all that the management of the road may do to prevent it) the trains will be running at a velocity far greater than that for which the outer rails on the curves have been banked or elevated, and when that condition is reached, the peril of displaced or overturned rails begins to loom up very big and threatening.

The danger of derailment through excessive speed is aggravated by the fact that the center of gravity of an electric locomotive lies very much lower (nearer the rail) than that of the steam locomotive. Consequently, the impact or surging of the locomotive against the outer rail, the hammer blow, as we might almost call it, would be much more severe for the same weight than in the steam locomotive. The center of the steam boiler of the present expresses on the New York Central road is about 9 feet 6 inches above the track, and when the engine lurches against the outer rails of a curve, there is something of a cushioning effect due to the fact that the weights are relatively high. But in the electric locomotive, the heavy motors are placed concentrically around the axles, the wheels are small in diameter, and the massive frame is hung low, with the result that there is a heavy concentration of weight near the rails. Moreover, the heavy rotors are fixed rigidly upon the axles. Taken altogether, it can be seen that the lateral hammering effect against the outer rail must be very much more severe in the electric than in the steam locomotive. Furthermore, about 70 tons out of the 95 tons total weight of the locomotive is concentrated on the four drivers and within a space of only 12 feet. This wheel base of the drivers is rigid, and must necessarily act with an intense local side thrust against the particular rail over which it is moving; nor did that rail in the case of the recent accident receive any assistance from the rail behind it, since this rail also was subjected to similar stress from the second locomotive.

There is no cause for wonder that in their attempt to iron out the curve into a tangent, these motors so far succeeded as to shear off eighteen spikes and push the outer rail several inches out of place—even though this shearing called for a lateral thrust of one hundred and twenty-four tons, exclusive of the thrust necessary to overcome the frictional resistance to side movement of the base of the rail on the tie plates. Such a side thrust, however, should have turned the motors over. But they did not turn over, and hence it is certain that the leading wheel of the drivers "ironed out" the curve, with a lateral wave motion which sheared the spikes in succession—as we have shown elsewhere in this issue.

The moral of this disaster points to the absolute necessity for a complete revision of the tables for super-elevation of outer rails on curves on steam railroads to meet the heavier stresses engendered by electric locomotives. The lavish expenditure of the New York Central Company in providing its electrical equipment should be sufficient evidence that the disaster is not due either to parsimony or to indifference. It was the belief of the engineers that the elevation of the rails was sufficient. Events seem to prove that it was not.

The New York, New Haven & Hartford Railroad Company are also about to install their electric service, in which, because of the low power (about 1,200) of their motors, they will be under the necessity of coupling up two locomotives (each weighing 80 tons) for their heavy expresses. They must therefore subject their curves every day to the trying conditions of double headers, which some missing contact shoes on one motor necessitated in the case of the ill-fated New York Central Express. Therefore we commend to the thoughtful consideration of the New Haven officials the proposition that both the safety of the public and the interest of their company demand that, before these double-header electric trains are put in service, every curve should be super-elevated to a degree commensurate with the conditions of high centrifugal stress, revealed by the eighteen sheared spikes and misplaced rail in the recent disaster.

According to L'Elettricita, it has been agreed between the Oerlikon and the Siemens-Schuckert works to commence immediately the plant for the electrification of the whole length of the St. Gothard Railway. The section from Zurich to Lucerne is to be constructed first as an experiment. This first section is the only one at present approved of by the Federal Railway Department, but it is stated that a syndicate has offered to convert at their own cost the whole part of the line which is situated in Switzerland by 1909, and to transfer it to the Swiss government on terms yet to be agreed upon.