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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.

A PORTENTOUS BRIDGE DISASTER.

Quite apart from the lamentable loss of life which it involved, the fall of the great Quebec cantilever bridge is the most disastrous calamity that could possibly have overtaken the profession of bridge engineering in this country. If we were to select out of the many fields of activity which are covered by modern civil engineering, some particular one in which the American engineer has displayed most signally his originality and freedom from tradition, we would choose that of bridge engineering; and if we had been called upon to name some one particular structure which stood as the highest exemplification of his skill in this particular branch of his profession, we would have selected the great cantilever bridge across the St. Lawrence River at Quebec. Not only did it contain the largest and most massive single span of any bridge in the world, but it was constructed upon a system of which the earliest types, on any large scale, were built in this country. Moreover, not only was the bridge American in type, but in the details of its construction also it was essentially American, the tension members consisting of eye-bars and the compression members of rectangular latticed sections, built up of plates and angle bars, the whole bridge being pin-connected. The skeleton design shows also the distinctive American features of wide panels, great depth of truss, and a resulting apparent lightness of the individual members. Furthermore, the consulting engineer of the bridge is perhaps the most distinguished bridge engineer in this country, his "Specifications for Railroad Bridges" having been for many years the standard authority on that subject. The actual design of the steelwork, moreover, represented some three years of careful labor on the part of another of our leading bridge engineers; and his computations had been checked, and rechecked, and every care taken to obviate any possible errors in the design. Let it also be borne in mind that the steelwork was built and the erection done by one of the biggest and most experienced bridge firms in the country. In view of the fact that this was the most monumental and daring structure of the kind ever erected, it was natural that special care should be taken, as it unquestionably was, both by the engineers and the contractors, to insure that everything connected with the bridge, from the inspection of the steel to the details of the erection, should be done with the utmost care and fidelity.

Nevertheless, on a comparatively calm summer's afternoon, the giant structure collapsed in one of its most important members—crumpled in upon itself—and sank into the shapeless mass of ruin so graphically depicted elsewhere in the columns of this paper.

The tremendous significance of this disaster lies in the suspicion, which to-day is staring every engineer coldly in the face, that there is something wrong with our theories of bridge design, at least as applied to a structure of the size of the Quebec bridge.

It would be a mighty consolation if only there were some evidence that faulty material or poor construction had entered into a vital part of the bridge; but thus far everything points to the contrary. There would be comfort also in the fact, if it could be proved, that the sudden fall of some massive member which was being lifted into place, or a sudden displacement of one of the erecting gantries weighing several hundred tons, had produced a dynamic shock throughout the huge framework, which had caused the stresses to rise beyond the maximum calculated stresses, and so had brought the bridge down. But alas! there is no evidence to show that sudden dynamic stress or anything approaching it occurred.

Are we to conclude, then, that those theories, those formulæ, upon which we have been building our bridges so successfully during the past quarter of a century, are inapplicable when the structure exceeds a certain magnitude? Can it be that for some unsuspected reason a stress per square inch which is perfectly safe in the end-post of a 500-foot railroad truss becomes perilous when used in the bottom chord of an 1,800-foot cantilever? As far as our engineering knowledge goes, there is no reason whatever why this disparity should exist. But if not, why is the Quebec bridge now lying at the bottom of the St. Lawrence River?

When we first heard of the fall of the bridge, we were satisfied that the failure was not due to the breaking of any of the tension members. Eye-bars, if the heads be carefully welded (and great attention is always paid to this point) are the most reliable portions of a framed structure. They are never known to give way. It was our expectation that the cause of failure would be found in the compression members; and, as we have shown elsewhere in this issue, the breakdown seems to have begun in one of these, namely, the bottom chord of the anchor arm of the cantilever. Two or three days before the accident it had been observed that this particular member was showing incipient signs of yielding, by springing from an inch and a half to two inches out of line, the deflection being toward the inside of the truss. We confess to profound astonishment that upon this discovery work was not instantly suspended. Instead of this, an engineer was dispatched to New York to see the consulting engineer, and another was sent to Phœnixville to the works of the bridge company. At about the very hour that instructions were being forwarded to suspend work, the bridge fell.

The methods of calculation of the strength of posts, struts, and chords, that is, of all members subject to compression, are based upon combined theory and experiment. Many years ago large posts which had been built upon the accepted formula were placed in a testing machine, and subjected to compression until failure occurred. These tests thoroughly verified the correctness of the accepted formula, and the latter has since been used universally in determining the dimensions of compression members necessary to carry any given load. This formula was used in designing the chords of the Quebec bridge. They were designed to carry, under the most severe conditions of full live load and maximum wind strain, a stress of 24,000 pounds on each square inch of metal. This is two-thirds of the elastic limit, or the limit at which the metal would begin to stretch. At the time of failure, this member was carrying only about 16,000 pounds per square inch, or less than one-half the elastic limit. Evidently, when compression members are built up according to the present methods, in sizes such as those in the Quebec bridge, there is a failure of the separate pieces to act together as a whole, and present that resistance to buckling which members built up in the same way have invariably presented when constructed in smaller sizes for bridges of less dimension.

Obviously, if confidence in future bridges of great span such as this is to be restored, the first step to be taken is to determine with absolute certainty why the failure occurred; and the best way to do this would be to build a compression member which is an exact duplicate of this one, and subject it to gradually increasing loads, until both the elastic limit and the ultimate point of failure have been passed. To do this would, of course, involve the construction of an exceedingly costly testing plant; but in view of the doubt which has been cast upon American principles as applied to the design of bridges of great span, not even this expense should be spared in an effort to get at the true conditions.

It is too early to predict that, as the result of these investigations, we may be led to adopt the circular sections (by far the most effective form for long compression members) used by the late Sir Benjamin Baker for the Forth bridge, but we do believe that in future bridges of this size, the ratio of diameter to length of compression members will be greatly increased, and continuous cover plates will be used in place of the present open lattice-work reinforcement.

SUCCESSFUL FLIGHT OF AN AEROPLANE CONSTRUCTED AFTER LANGLEY'S MODEL.

Spurred on by the success of the Wright brothers in this country, and by the fact that these gentlemen have made a trip to France with the purpose of selling their aeroplane, a number of the well-known French experimenters have been making every effort to fly with a heavier-than-air machine. In a competition of models held last June in France, several models on the following-plane type, such as was first built and used successfully by the late Prof. Langley, made the best performances. Since then, M. Louis Bleriot has constructed and experimented with a full-sized machine of this type with quite remarkable results. A complete description of Bleriot's work will be found in the current Supplement. Suffice it to say that with a machine having only about 215 square feet of supporting surface and weighing, all told, 617 pounds, he succeeded in flying a distance of 870 feet in two successive jumps of 401 and 469 feet, separated by a space of 39 feet, throughout which he touched the ground. His machine developed a speed of over thirty miles an hour. Its movement in a vertical plane was controlled by a horizontal rudder at the front end, this rudder being operated by a movable seat mounted on rollers, which was moved forward or backward similarly to the seat of a racing scull. The most notable part of this intrepid aviator's performance was the making of a turn at the end of the field over which he was experimenting, and landing with the wind at a speed of over thirty miles an hour without damaging his machine. This was a splendid demonstration of the inherent stability of the Langley-type machine, and complete proof that had Prof. Langley ever been able to successfully launch his machine, it would have made a successful flight. One of the most remarkable points to be noted with regard to M. Bleriot's performance is the fact that he had a motor of only about 20 horse-power, and each square foot of supporting surface was required to carry 2.8 pounds. One and one-half to two pounds per square foot is generally considered to be a good load for a machine of this type. Coming as it does at the moment of completion of the aeronautic trophy offered by this journal in commemoration of Langley and his machine, M. Bleriot's performance should put at rest all question as to the value of the type of machine proposed and successfully experimented with on a small scale by the late Curator of the Smithsonian Institution.

THE EVOLUTION OF MATTER.

The discovery of radium rays and other radiations has resulted during the last few years in a revolution, not only in the field of experimental physics, but of natural philosophy generally. Such fundamental laws as the laws of the conservation of energy and matter have lost a great part of their old prestige, and are far from occupying their former position as pillars of natural philosophy.

While the atom until recent years was considered as indestructible, radiation phenomena have shown that not only "radio-active" substances, but all bodies generally give out continually a stream of minute particles. These particles, which are thrown off by the atom at an enormous speed, possess the properties of rendering the air conductive of electricity, penetrating any obstacles on their way, and undergoing a deflection under the influence of magnetic or electric fields.

That these phenomena are common to all bodies has been first recognized by Dr. Gustave le Bon, who in a treatise recently published* deals with the significance and consequences of these theories.

For the old axiom, "Nothing is created, nothing is lost," Dr. Le Bon substitutes the principle, "nothing is created, all is lost." He considers radio-active phenomena as evidence of a permanent vanishing of matter and a gradual decay and transformation of it into an immaterial state, while passing through a number of intermediary conditions; the immaterial state corresponding to what is called ether. Ether and matter appear to him to represent things of the same order, the different forms of energy, namely, electricity, heat, light, matter, etc., being manifestations of one identical thing, differentiated by the stability and nature of its equilibria.

The products of this decomposing of atoms, according to recent researches, form substances intermediary by their properties between ponderable bodies and imponderable ether, that is, between two worlds which science has so far kept strictly separated. While matter was once considered inert, it now appears as an enormous reservoir of energy (inter-atomic energy), which it is able to give out without deriving anything from outside.

This inter-atomic energy manifested during the decay and disintegration of matter would result in most of the forces of the universe. The only essential difference between force and matter would be that the latter is a stable form of inter-atomic energy, while the former is unstable. By the dissociation of atoms, the stable form of energy called matter would be transformed into its unstable forms—electricity, light, heat, etc.

The idea recently suggested that a transmutation of atoms, according to the dreams of alchemists, some day might become quite practicable, is obviously in agreement with these theories. In fact, according to Le Bon, the law of evolution, which according to Darwin is true of living beings, would be applicable also to the simple chemical bodies or elements, chemical species being as far from invariable as living species.

The practical interest attaching to the doctrine of the permanent decay of matter, due to its transformation into energy, will be fully appreciated only when a process for accelerating the disintegration of bodies has been found. When this has been achieved, a prac-

* L'Évolution de la Matière, Ernest Flammarion, pub., Paris.

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tically infinite source of energy will be at the free disposal of man, the consequences of which can hardly be foreseen.

SEARCHING FOR PARASITES TO FIGHT FRUIT PESTS.

BY H. A CRAFTS.

A most unique calling is that of George Compere, chief field entomologist for the Department of Horticulture, State of California, and also for the Department of Agriculture of Western Australia. His work consists in searching the world for beneficial insects, or parasites, for the preservation of the fruit industry of the two states mentioned, from the ravages of insect fruit pests. The reason that he is able to serve both governments at once to their mutual satisfaction is that the fruit pests of California and Western Australia are identical with but few exceptions. Two of these exceptions are comprised in the codling moth and the fruit fly; the first is prevalent in California, but not in Western Australia, and the reverse is true of the second.

The prime object of three out of the seven world tours made by Compere was the finding of the parasite, or natural insect enemy, of the fruit fly; yet Compere did not forget the interests of his own State while making these tours; among the beneficial insects calculated to combat the fruit pests of California obtained by him during these travels was the parasite for the codling moth, which he found on the western coast of Spain, and one for the purple scale, discovered in the interior of China.

Compere's methods are peculiar to himself. When starting upon one of these insect expeditions, he severs all social ties, and remains in communication only with the horticultural officials of the two countries employing him. He goes alone and unattended, and engages no helpers until he arrives in a field of immediate search; then he may hire a guide, and perhaps an interpreter.

During his long sea voyages he is immersed in his collection of books on entomology, and studies them carefully in their bearing upon his peculiar line of investigation. But no sooner is a landing made, although it may be only for a few hours' stop at some lonely island in the middle of the Pacific Ocean, than Compere seizes his paraphernalia and hastens ashore to hunt insects until the steamer shall proceed.

His outfit on one of these expeditions is simplicity itself. It consists of a large sheet of white cotton cloth, a stick, an insect-case, and a microscope. As soon as he espies a tree or shrub that he thinks may be inhabited by some important member of the insect family, he proceeds to spread his sheet underneath its boughs, and when that is done he begins to beat the branches with his stick. When he has dislodged a great number of insects, he falls upon his knees, with the microscope to his eye, and makes a careful scrutiny of the sheet. Should he discover any interesting individual he proceeds to capture it, and consign it to his insect case.

And thus Compere goes about the world, hunting every nook and corner; plunging into jungle, morass, or tropical forest in his tireless search for more insects, regardless of personal danger. Once while traveling in India he found himself in a plague-infected district, and lost five guides in succession from the disease before he had completed his search. Then he was detained in quarantine on the frontier, and when he was about to leave, the local officials took it upon themselves to fumigate his baggage. Among his baggage was his case of insects, and every one of the creatures was killed by the noxious fumes. Then all the labor Compere had been to, all the dangers he had braved upon this expedition, came to naught. But the next season saw him on the ground again, and this time he was more successful.

One may ask why it becomes necessary to search in foreign lands for these beneficial insects, and why they may not be found within the borders of the State of California in conjunction with the injurious insects. This is quite readily explained: California is a new State, and her fruit industry is of comparatively recent origin and of very rapid development. Neither the injurious nor the beneficial insect was in the State originally. The first came in through negligence and lack of foresight; the second can be brought in only by great labor and research. The early fruit growers were more influenced by enthusiasm for the introduction of new and rare fruits than by wise caution in not importing at the same time about all the fruit trees in the known world. The pests came in through infested trees, shrubs, green and dried fruits, etc., because in the early days no one thought of horticultural inspection and quarantine such as California has since established; but the parasites did not come with them; so the pests gained a foothold, multiplied by the million, and have been productive of infinite evil.

Again, it may be asked why it is so difficult to obtain these parasites even in foreign lands, which are apparently their natural home. This question is also easily answered: In lands where pest and parasite exist in conjunction, there is eternal war between the two species; one is on the offensive, the other on the defensive, with the parasite always in the ascendency.

The pest gradually disappears under the constant attacks of the parasites, and as it disappears the parasite is deprived of its natural food; for under no conditions will it subsist upon a vegetable diet; and then the parasite disappears by reason of a food famine. So Compere does not look for a parasite in any locality where the pest is prevalent, for the very presence of the pest is proof positive that the parasite is not existent in that neighborhood, but must be looked for in some place where the pest is very scarce; and the pest or natural food of the parasite being scarce, of course that insect is found in diminished numbers; consequently the search for it is made much harder.

After the search has been made and the insect found, comes the delicate and difficult task of transporting a colony to one or both of the two countries in whose interest the search has been made. This requires patience, perseverance, and a considerable amount of ingenuity and inventive genius. You cannot pick up any kind of an insect and put it in your pocket and carry it home some 25,000 miles, nor can you send it by mail or express and stand any chance of its arriving at its point of destination alive and in good condition. There is a difference in insects and the ways of handling them.

Take Compere's experience with the parasite for the fruit fly! The discovery and final landing of this insect in West Australia required three consecutive tours of the world, as I have already stated.

There was one long and unsuccessful hunt in the Orient; then Compere heard of the insect having been in Washington, D. C. To that city he went, and learned that the creature had been sent to the Smithsonian Institution in that city for identification by Dr. H. Von Ibering, director of the museum at Sao Paulo, Brazil, but had been returned after identification. That was a good enough clew for Compere, so he hurried down to Bahia, and in that neighborhood found the object of his search, in the shape of a large beetle.

There are two general classes of parasites that are sought after to prey upon the fruit pests—the internal and the predaceous. The first is one that lays its eggs in the grub of the injurious insect, and as the young hatch and levelop they feed upon the surrounding tissue, and the pest is killed in embryo. The predaceous parasite is one that in its mature form pounces upon the pest insect in whatever form the latter may be found and devours it.

The Brazilian beetle discovered by Compere belongs to this last described class and the naturalist decided to herd a lot of them together, confine them and then personally conduct them all the way to Perth, West Australia, *via* London and Marseilles. He had constructed a tin case containing compartments and he divided his colony of beetles into sections, and put a section into each compartment. Then he secured passage on the first steamer out that was going his way; secured on board a corner in which to keep his insects, and then provided for feeding them on grubs on the voyage. He secured an ice box, charged with ice, and filled it with fresh meat; then he caught a lot of blow flies and shut them up in a tin case by themselves. Next he provided an open case in which to place a piece of meat for exposure to the blow flies, and still another case in which to place his maggots as fast as they developed upon the meat.

The maggots were used as food for the beetles. But the latter proved to be hungry fellows, and they devoured between one hundred and two hundred maggots per day, and Compere was compelled to exert himself to secure a sufficient amount of food, and he was constantly filled with anxiety as he observed that the bugs were regular cannibals, and just so soon as grubs became short, turned upon one another.

He kept them alive, owever, until he reached London, and in that city, hiring a cab, he scoured the precincts in search of suitable food for his hungry beetles. Happily he ran across a firm in Gray's Inn which made a business of supplying fishermen with bait, and of them he bought two gallons of maggots.

These lasted until he reached Port Said, and in that vicinity he discovered that the very fruit fly which was the natural food of the beetles was prevalent in that region. Here he secured sufficient food for his beetles for the balance of the journey to West Australia, where the insects were landed alive and in good condition, the journey from Bahia to Fremantle having occupied a period of forty-six days.

But in West Australia a new and unlooked-for difficulty was encountered. It was in the dormant period of the fruit fly that the beetles arrived, and therefore there was no food for them. They were placed in cold storage, in the hope of keeping them alive until the fruit fly season opened, but in this the entomologists were disappointed, and the next year Compere found it necessary to make another trip to Brazil after more beetles. This expedition was properly timed, another colony of beetles was secured and successfully transported to West Australia, where the insect has since been bred by the million and turned loose upon the fruit fly.

The securing of the purple scale parasite in China and its transfer to California were accompanied with almost equal difficulties. This parasite, unlike the fruit fly parasite, is a minute wasp, so small as to be almost invisible to the naked eye, and is one of the internal species.

It was transferred in this fashion: The California horticultural officers at San Francisco secured from Southern California a number of small lemon trees heavily infested with purple scale, and these were potted, boxed up, and dispatched to Compere in China, as soon as he had found his parasite.

As the little trees reached him he unboxed them and exposed them to the parasite until they became thoroughly infested with that insect. Then he reboxed the trees and dispatched them back to California.

The product of his first expedition died in cold storage on the way over from Hongkong, and this necessitated making a second trip. This latter was successful and the little wasps are being reared in their new home in immense quantities and sent into the scale-infested orchards of the southern part of the State.

SCIENCE NOTES.

Work on the Panama canal is progressing faster than has been calculated, and as a result it is estimated that the expenses for the current year will exceed appropriations by about $8,000,000. The office of the canal commission has issued the following statement: "With the present organization and the progress which now is made, the canal can be completed more rapidly than by restraining expenditure within the appropriations which were made at the last session of Congress to continue the work until 1908. Work on the locks and dams at each terminus has been opened and will be pushed vigorously during the year, while very little was done at those places during the fiscal year which terminated June 30, 1907. The time of completion of the canal appears to depend now upon work at Gatun, rather than on the work of excavation, which has hitherto been generally taken as the determining feature. The progress in this direction has been faster than anticipated, and the appropriation made at the last session of Congress would not be sufficient to supply the necessary plant to begin laying the concrete in the locks and dams during the next fiscal year, although progress already made indicates that such a beginning is advisable. In order to avoid reducing the force, to keep within the expenditures already authorized for this fiscal year, the chairman of the commission has recommended to the Secretary of War that the work be allowed to proceed, and that Congress be appealed to at its next session to make good any deficiency in the funds now available. If the funds requested are not provided it will, of course, be necessary to reduce the rate of expenditure to keep within the appropriations on hand. About $8,000,000 in excess of the appropriations already made could be used to advantage in pushing forward the work during the present year."

Extended experiments recently conducted in this country have shown clearly that fruit trees suffer very materially, and are often killed outright, when grass is allowed to grow under the tree and close up to the trunk. Various probable reasons for this effect, such as the removal of plant food and of water by the grass, also the supposed liberation of carbonic acid, which might prove injurious to the roots of the trees, were respectively demonstrated to be outside the primary cause of injury, and, finally, after seven years' work, it was concluded that the injurious effect could only be due to some poisonous substance formed in the soil by the roots of the grass. On the other hand, it is a well-known fact that in many instances considerable difficulty is experienced in obtaining a growth of grass under trees. Mr. C. A. Jensen has given an account of certain experiments bearing on this point in Science. There is distinct evidence that plants produce toxic conditions in the substance in which they grow, and as a rule the excretions given off by the roots of a certain plant are more toxic to the same or a nearly related plant than to plants not so closely related. The effect of tree seedlings on the growth of wheat was tested, and after eliminating as a cause of injury such factors as removal of plant food or water by the tree-roots, it seemed that the roots of the latter had some direct effect on the growth of the wheat, which suffered in all the experiments. The seedlings were placed in plant pots, hence the roots of the tree and those of the wheat plants were in close contact. Trees of various kinds were used in the experiments, and the retarding influence, although noted in every instance, differed in degree; cherry was least active in checking growth, pine most so. The conclusion arrived at was that the effect of trees on wheat appears to be due to the excretion by the trees of substances toxic to wheat.

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