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CAPPED PROJECTILES AND PANIC LEGISLATION.

Several years ago during some armor-plate trials in Russia, in which the plate had thoroughly beaten the projectile, it occurred to some one to cover the hard face of the armor with a thin plate of soft steel. The result was magical, a shell which splintered hopelessly on the hard face now boring its way through both plates with impunity. It was evident that the soft plate served to embrace and hold together the point of the projectile during the critical moment when it was breaking its way through the intensely hard surface of the armor. Once through the surface, penetration through the softer body of the plate was easy.

Projectiles, however, could not carry soft plates around with them, nor was it necessary. A small cap of soft steel, attached to and covering the point of the shell would serve equally well; and so the capped projectile took its place as one of the most effective inventions in the development of guns and armor. The invention was taken up and perfected by the Johnson firm of Spuyten Duyvil, New York, and their fluid-compressed, steel-capped projectile secured a world-wide reputation when a 12-inch shell penetrated 18 inches of Harveyized steel, although striking the plate obliquely at an angle of 21° from the normal, and with the customary velocity of 2,000 feet per second.

But all this is ancient history, and was duly recorded in the SCIENTIFIC AMERICAN, of December 5, 1896, when illustrations were given of a 6-inch projectile which, after penetrating 10 inches of Harveyized plate, had sufficient energy left to carry it 8 feet into the sand embankment at the rear—a total energy equal to the penetration of 12 to 14 inches of plate. The perforation of Harvey plate and of Krupp plate of lesser thickness, has subsequently been accomplished with capped projectiles, probably at every armor-proving ground in the world.

It seems that on a recent occasion our own navy officials, by giving it a high velocity, put a 6-inch capped shell cleanly through a 6-inch Krupp plate, and drove a shell of the same caliber through 14 inches of Harveyized steel. Both were remarkable performances, though if we bear in mind the experiments of 1896 above referred to are in no sense phenomenal. Nothing would have been heard of the matter outside of military circles had not the item found its way to the awestruck ear of a member of the Senate, who, communicating the secret to others, produced such consternation that the Senate forthwith closed its doors, and in secret session debated what emergency measures must be taken in view of the profound revolution in the relative efficiency of guns and armor which had just taken place, and had only now fortuitously come to the knowledge of Congress.

By some occult process of reasoning, this routine proving-ground test was taken to imply that the vaunted superiority of face-hardened armor being now shown to be a myth, there was herein clear proof of the fraud (long suspected) which the armor plate makers were perpetrating upon the government; for who would now think of paying $450, to say nothing of $545, per ton for plate that had just been shown to be little short of worthless?

The incident has an obvious moral; for surely it is not asking too much to suggest that the gentlemen upon whom devolves the grave responsibility of saying the last word as to what shall and what shall not be done in matters naval and military, should keep themselves so far informed on these technical questions as to be able to debate them with intelligence, dignity, and deliberation.

THE SHRINKAGE OF LAKE NICARAGUA.

In the current issue of the SUPPLEMENT will be found an article by Prof. Heilprin, entitled "The Shrinkage of Lake Nicaragua," which is certainly the most significant, we had almost said dramatic, contribution to the literature of the Nicaraguan region that has yet appeared.

In our issue of February 24, the same author, whose geographical and geological attainments give him eminent authority, showed that there is abundant evidence, drawn from the inconsistency of early recorded levels with those of later surveys, and from other phenomena, that there has been a gradual falling of the lake level. A reply to this article by Mr. C. Willard Hayes, geologist of the Walker Canal Commission, was published in the SUPPLEMENT of April 28, and in the present article, while replying to Mr. Hayes, Prof. Heliprin fortifies the position taken in his former article, by proving from the records of rainfall, evaporation and outflow of the lake, furnished in the report of the Walker Commission of 1897-99, that there has been a shrinkage in the waters of the lake during the past twenty years.

It is evident that, if any doubt exists as to the permanence of the lake, a similar doubt exists as to the permanence of the canal; for not only is Nicaragua, with the canalized San Juan River, to form the major portion of the canal, but it is upon the maintenance of the lake at or above a certain specified minimum level that the very existence of the whole system depends. Should the waters of the lake in time fall below a level which would afford less than 30 feet (the proposed depth of the canal) at the points where the canal enters and leaves the lake, there would be absolutely no remedy for the disaster.

Does such a danger exist? Is there any evidence that the average losses by evaporation and outflow are in excess of the average gains by rainfall in the Nicaragua watershed? The question can be answered by gathering all the recorded data on the subject, and by a simple process of addition and subtraction, determining whether the volume of the lake is increasing, stationary or undergoing a steady shrinkage. The necessary data are furnished by careful records taken at Rivas, on the Pacific side of the lake, during the years 1880 to 1898 inclusive, and it is from these data that Prof. Heilprin has arrived at the discouraging conclusion "that the lake—unless, indeed, the official reports are inaccurate—has been steadily and progressively undergoing shrinkage, and that it must continue to do so in the future."

The determinations of altitude of the lake made by Galisteo, in 1871, and by Baily, in 1838, show that it formerly stood at a much higher level than that established by recent surveys, a fact which is confirmed by the report of Collinson to the Royal Geographical Society, in 1867, who states that "even the least observant native, dwelling on the lake, will tell how its banks are rising year by year visibly before his eyes." The most comprehensive record of rainfall, evaporation, etc., is that contained in the report of the Nicaragua Canal Commission of 1897-99, which, although it makes no specific analysis of its own figures to determine the question of net gain or loss in the volume of the lake, does actually afford confirmation of the statements of the early engineers, as Prof. Heilprin shows in his article.

It is made plain from the report that the intake of Lake Nicaragua—rainfall and drainage from its drainage basin—is apparently for almost every year less than the output—the loss due to evaporation and outflow; while in exceptionally dry years the evaporation alone is greater than the entire intake.

From November 1, 1889, to June 1, 1891, the total rainfall would have raised the level of the lake 45.75 inches. The evaporation alone would have lowered it 95 inches, a loss, outside of what would have run off through the San Juan River, of over 4 feet. The aggregate loss during three dry spells, not taking count of outflow through the San Juan, was 10 feet 10 inches.

The compensations for such losses must be found in periods of extraordinarily heavy rainfall; but despite the fact that immediately after excessive rains the lake has been known to rise two feet in six weeks, the greatest net accession to the lake for any entire year, during a period of 20 years, was considerably less than 2 feet.

In the year 1898, when the rainfall was 108 inches, the net rise of the lake was only 18 inches, and a comparison of the records show that during 19 years of successive observations (1880 to 1898) there were not more than four periods, the years 1893, 1897, 1898 and possibly 1886, when the lake held its own, and during these years combined the actual gains were less than 5 feet. On the other hand, in the single year 1890, when the rainfall at Rivas was only 31·81 inches, the loss was as great as the gains for the entire 19 years!

In calculating the net result of all the causes of supply and loss affecting the lake level, the average recorded evaporation is taken as 55 inches, and the outflow through the San Juan as 42 inches, or one-half the amount in the extremely wet season of 1898. On this basis there is a total loss of 363 inches as against a total gain of 114 inches, or a net loss of 20 feet 9 inches. From this result the author of the paper concludes that for a long period of years Nicaragua has undergone a very marked and progressive shrinkage.

It is true that the outflow through the San Juan may be controlled and water may be stored in wet seasons against the deficiencies due to drought; but although the evil day may be thus postponed it is only a question of time, if the lake be steadily shrinking, when the surplus storage will be inadequate to meet the ever-growing deficiency.

We agree with the author of this paper that "it is hardly less than amazing that these reports should not have been analyzed before, and their bearing given full consideration;" and, we trust, that Congress will recognize, in the grave considerations thus presented, a further inducement to await the results of the searching investigation which is now being made by the President's commission.

ELECTRICITY IN THE FIELD OF TRANSPORTATION.—A FORECAST.

In no branch of science has the century now fast nearing its end witnessed more rapid advances or remarkable applications than in electricity, which, in a brief space of one hundred years, has developed from a scientific curiosity to one of the most potent forces that enter into our industrial life. It is still but ill-understood, and not even adequately definable. So vast have been the changes which it has already wrought in chemistry and manufactures, and so powerful may be the influence which it is destined to exert over the arts, that one involuntarily looks into the future for a glimpse of its possibilities in the twentieth century.

Present developments give no reason to expect that electricity will ever completely supersede steam as a motive power of great railway systems. In the transportation of heavy loads through long distances, the use of electricity is accompanied with many inconveniences and disadvantages. The steam-locomotive, on the other hand, ever remarkable for its great tractive power and high speed, has, in late years, been so considerably improved that it will undoubtedly hold its own in the economical, long-distance haulage of freight. Improvements in smoke-consuming devices, in constructions for lessening vibration, and in arrangements for increasing the heating surface and boiler capacity, follow one another so rapidly that the merits of concentrated power, cleanliness and compactness are almost as characteristic of the locomotive as they are of the electric motor. But, although electricity may never be exclusively used as the motive power of our large railroads, there are certain conditions under which it may be far more satisfactorily employed than steam. Scarcity of coal and a superabundance of water-power, for example, may favor the construction of electric rather than steam roads. In Switzerland and the Alpine regions of Italy, short trains of moderate speed, running at frequent intervals and carrying but few passengers, are chiefly employed, electric power being used for reasons of economy; while there is every indication that electricity will be exclusively used in the subway systems of the future.

For suburban travel and the street railways of large cities, we find that electricity is admirably adapted to meet the requirements of punctuality, security, and speed. Electric power is eminently suited to the needs of the small road; the cars are small, the trains short, the superstructure light, and the system cleanly. Whether the over or the underground trolley or the storage battery will be the prevailing system, it cannot be doubted that for city and suburban service electricity will remain the best form of motive power. So widely is it now employed on tramways, that it practically monopolizes the field; and further advancement must be looked for only in intensive improvement, in increased efficiency and safety.

That electricity will actually supplant steam on short, industrial roads, such as those that connect mines with foundries, and factories with shipping wharves, is as certain as that it will be generally employed in city and suburban traffic. The small electric locomotive of great tractive power, easily controlled, ever ready for service, has proven itself of untold value, and, to a certain extent, has already taken the place of the steam-locomotive. The field which is here opened to electricity is not so limited as one might be inclined to imagine. The centralization noticeable in all branches of commerce, the combination of small factories to form giant industries, is becoming more pronounced with each succeeding year. Industrial plants, which cover acres of ground and which swarm with workmen, require a quick means of transporting material from building to building, and for this purpose electricity is the most convenient and, under many conditions, the cheapest form of energy that could possibly be employed. In many of these establishments large generating plants have been already built to drive the many motors, cranes, machine-tools, and labor-saving appliances, and the utilization of the same current employed in driving these machines, to operate short railways would be both practicable and economical.

Transportation by water will be affected by electricity less markedly than transportation by rail. The electric appliances which are now largely used on European canals have contributed much to increase the efficiency of these and other waterways. Electrically-operated cranes, elevating apparatus, and gates are multiplying; and the mule that now reigns supreme over the towpath is gradually giving way to the small, powerful, electric locomotive, capable of towing several barges at a time. On ocean-going steamers, electricity will occupy a minor place. At present it is employed

in lighting and in operating the steering-gear and various auxiliary machines. On warships it will find a more extensive application. Although it will not supersede steam as a means of propulsion, it will be more widely used than at present in the manipulation of turrets, guns and ammunition hoists, and the operation of deck winches and boat cranes.

Electric communication on land, in spite of its phenomenal development, may still be vastly improved in economy. Our present system of rapid telegraphy is expensive; the sending of a message by wire is even yet far too costly for the ordinary affairs of mankind. If the twentieth century inventor will concern himself with increasing the efficiency and reducing the cost and expense of existing means of electric communication, he will confer more solid benefit than by solving the problem of electrical vision or elaborating a system of wireless telegraphy.

A NATIONAL NEED.

There has been submitted to Congress a bill which proposes to merge the Office of Standard Weights and Measures in a new bureau, to be known as the National Standardization Bureau, whose function shall consist in the custody of the national standards; the comparisons of standards used in scientific investigations, engineering, manufacturing, commerce and educational institutions with the standards adopted or recognized by the government; the construction, when necessary, of standards, their multiples and subdivisions; the testing and calibrations of standard measuring apparatus; the solution of problems which arise in connection with standards; the determination of physical constants and the properties of materials, when such data are of great importance to scientific and manufacturing interests and are not to be obtained with sufficient accuracy elsewhere. The bureau is to exercise its functions for the government, for any State or municipal government within the United States, or for any scientific society, educational institution, firm, corporation or individual engaged in manufacturing or other pursuits requiring the use of a standard measuring instrument.

The importance of this bill is evident from a brief review of the conditions which call for the establishment of a bureau of this kind. It has always been acknowledged that the selection and care of the original standards of length, mass, capacity and temperature, to which subjects attention, until recent years, has been almost exclusively confined, is one of the most important branches of scientific work that comes under the control of the government. The remarkable developments which have taken place of late years in pure and applied science have enlarged the field of such duties, until it now includes so many branches of physical and chemical research as to call for a complete laboratory, furnished with means for making the most refined measurements known to modern science, if the proposed Standardization Bureau is successfully to cope with its duties.

Germany, England, Austria and France have established bureaus and departments, more or less of the kind contemplated in this bill, and it only requires a study of the duties of these institutions, and the generous appropriations granted for their maintenance, to be satisfied of the importance, in foreign eyes, at least, of problems pertaining to standards and standard measuring apparatus. The necessity for a United States Bureau is proved by the extraordinary rapidity with which institutions of learning, laboratories and scientific societies are being established throughout the country, the rate of their growth never having been equaled in the history of any other nation. The work done in these institutions requires reliable standards for which, at present, they are obliged to go abroad. The introduction of accurate scientific methods into our various industries moreover, calls for a multitude of standards of far greater accuracy than was formerly required. Thus to secure the most economical results it is often necessary to have an accurate knowledge of the high temperature of a furnace, or the low temperature of a refrigerating process; while important commercial transactions are based upon the reading of electrical apparatus, inaccuracies in which would result in great injustice and financial loss. There is a call, moreover, for many standards and instruments of precision in the different scientific departments of the government. Further proof of the necessity for this bureau is found in the recent acquisition of territory by the United States, which will involve readjustment of the system of weights and measures in the countries affected.

Hitherto the manufacturing of scientific apparatus and instruments of precision has been confined almost exclusively to foreign countries, although it is satisfactory to note that this country promises before long not only to be able to supply its own needs, but to produce instruments fully equal to the best of foreign makers. It is absolutely essential, however, if American manufacturers are to secure the requisite degree of uniformity and accuracy, that they have access to a standardizing bureau such as is provided for the manufacturers in other countries. It is sincerely to be hoped that Congress will look favorably upon this bill and not only enlarge the function of the present office of Standard Weights and Measures, but provide it with an adequate laboratory, equipment, and working force.

THE METHODS EMPLOYED BY THE ASSAY COMMISSION.

BY MARCUS BENJAMIN, PH.D.

Each year the President of the United States appoints through the Director of the Mint, a Commission consisting usually of fifteen persons, with the Judge of the District Court for the Eastern District of Pennsylvania, Controller of the Currency, and the Assayer of the assay office in New York, ex-officio, which is required to meet in Philadelphia on the second Tuesday in February for the purpose of examining the fineness and weights of the coins reserved by the mints in Philadelphia, San Francisco, New Orleans, and Carson City. An appointment to serve on this Commission is an honor highly appreciated by the scientific men of the country, and on the list of those who have served since its creation in 1874 may be found the names of many of our best known chemists and physicists.

The present writer has had the good fortune to meet with the Commission on two occasions, and believing that the readers of the SCIENTIFIC AMERICAN would be interested in learning something of the methods by which the government certifies to the public that the high standard of its coinage is preserved, the following has been written:

The Commission meets at the time appointed in the long room of the mint in Philadelphia where the coin collection is kept, and after organizing under the chairmanship of the Judge of the Eastern District of Pennsylvania, three committees are named, as follows: One on counting, one on weighing, and one on assaying, and then the Commission adjourns until such time as it shall be convenient for the committees to make their reports. Almost immediately after adjournment of the Commission, the counting committee assembles, which consists of the members of both the assaying and weighing committees, and to them are given the sealed packages containing samples from the several mints.

Each mint is by law obliged to take assay pieces from each coinage in each month in the proportion of one for each one thousand pieces, or any fractional part of one thousand pieces, in the case of gold coins; and of one for each two thousand pieces, or any fractional part of two thousand pieces in the case of silver coins. These are sealed in an envelop and shipped quarterly by express to the mint in Philadelphia, where they are carefully preserved in a pyx, under the joint care of the superintendent and the assayer to await examination by the Commission.

The committee on counting proceeds at once to open these envelops and verify the count which is indicated on the outside of the envelop. This operation generally requires two days, and in the case of the Mint Commission that met in February this year, it was said that 41,271 pieces of money, both gold and silver, representing a value of $125,103, were submitted before the Commission.

While this money is being counted samples are selected for the use of the weighing committee, and also for the assaying committee. Those taken by the weighing committee are removed to the balance room where, under the direction of the chairman, they are carefully weighed on a large delicate balance, precaution being taken in the first instance to carefully test the weights by a set of standard weights, the accuracy of which has been previously testified to by a certificate from the Bureau of Weights and Measures of the United States Coast and Geodetic Survey.

The following deviations are allowed: In the double-eagle and the eagle, one half of a grain; in the half-eagle, the three-dollar piece, the quarter eagle, and the one-dollar piece, one-fourth of a grain. In the silver coins the deviations are as follows: In the dollar, the half, and the quarter dollar, and in the dime, one and one-half grains.

The work of the assay committee is more complex, and it requires several days for its completion. Samples having been taken of the different coinages, beginning with the gold, these are then removed to the assaying department, where a piece of each coin is selected. Pieces representing about a quarter of the coin are struck off with a cold chisel. These pieces are then rolled out and numbers stamped on them, after which they pass to a special weighing room, where one-half of a gramme of gold is weighed from each sample. Sets of fourteen are generally taken, and of these two are of pure standard gold. The weighings are wrapped in a lead sheet with a certain proportion of silver, and the little cornets, as they are called, are then taken to the assay furnaces, where they are cupeled; that is to say, placed in small bone ash cup which absorbs all of the lead and other impurities. The silver button is taken from the cupel when cold, and after all adhering dirt is removed, is rolled into a convenient shape and then twisted into a little coil which is put into a small metallic basket. These baskets contain a number of apartments, and when the proper number has been obtained, the entire basket with its contents is deposited in a bath of nitric acid. This dissolves out all of the silver, leaving the gold in its purity. The gold thus obtained is then weighed, and the result represents the actual amount of gold contained in the sample. By this means the commission, knowing the original weight of the sample, and having extracted all the impurities are able to tell exactly the proportion of gold contained in the coin, or as it is commonly called, the "fineness." The two samples of pure gold serve as a check on the process, and are also used as a means of correcting the slight differences due to the conditions of the furnace, i, e., too great heat, or not enough. By reference to the Report of the Proceedings of the Assay Commission for 1899, the first four specimens of eagles from Philadelphia showed a fineness of 899·6, 899·8, 899·7 and 899·8.

When the samples of the gold coinage have all been assayed the committee then takes up the silver, the assay of which is accomplished in the following manner: As was the case with the gold coinage, samples of each denomination are selected and pieces from each coin are cut with a chisel. These samples are then rolled out and numbered by means of a punch, after which they are sampled by means of a punch which strikes out a number of small pieces a little larger than the head of a pin. Eleven and one-half grammes are then weighed and put into stoppered eight-ounce bottles into which 10 cubic centimeters of nitric acid are dropped. The bottles are then heated so as to dissolve the silver, after which, when they are cooled, 100 cubic centimeters of standard salt solution is added for the purpose of precipitating the silver. The bottles, in sets of twelve, are placed on a shaker which is operated by power and thoroughly shaken for four minutes in order that all of the silver may be separated in the form of chloride from the solution. The small remaining fraction of silver is then precipitated with a decinormal solution of salt, by means of which the exact proportion of silver is determined. The expert who finishes the operation possesses a very accurate eye, and, by adding a drop more or less of the standard solution, is able to tell to within a tenth of the exact amount of solution required to entirely precipitate the silver. In this case, as with the gold, two specimens of standard pure silver are carried through the operation in order to check the result.

On the completion of the work of the weighing and assaying committee, the Commission is again convened, and the reports of the different committees submitted, after which every member of the Commission is required to sign the report. A pleasing feature of the experience is that at the close of the meeting the superintendent of the mint presents each member of the Commission with a handsome medal that has been prepared for the occasion, containing the head of the president on one side and an appropriate symbolical design on the other, in recognition of his services.

A SPEEDY BUSINESS TRANSACTION WITH CHINA.

It is a trite saying that we have annihilated space by the submarine cable. The remarkable ease with which business can be transacted with the Antipodes was shown a short time ago in the case of a Chinese client of the SCIENTIFIC AMERICAN Patent Agency, residing in the interior of China. He had given instructions that he was to be cabled to when his patent was allowed. He was cabled on the third of May, the rate being $1.60 per word: on May 7, a firm of New York bankers paid the funds necessary for the filing of several foreign patents, the instructions having come from Hong Kong by cable. In the four days that had elapsed between the sending of the cablegram and the paying of the money, messages were transmitted over a distance almost as great as the circumference of the earth at the equator, and had the business been transacted by mail the shortest time by the postal routes would have been fifty days provided that close connections were made.

EXCAVATIONS have been instituted on the site of ancient Knossos near Candia and the remains found are important. Mr. Hogarth has discovered a Mycenæan building on the hillside opposite the famous "Palace" site at Kephala, it seems to consist, as far as it has been cleared, of three halls, in two of which stand square pillars, a feature not hitherto apparent in structures of this period, except in a rude form at Phylakopi, in Melos. The walls were faced with thin slabs of white gypsum, many of which remain in their place, and the floors are paved with similar slabs. In what was apparently the tank of the house were found about forty vases, mostly capable of restoration and all in pre-Mycenæan. In the building itself have been found several gems and beads, obsidian tools and miscellaneous objects, besides hundreds of fragments of Mycenæn vases, which are more varied and elaborate in in design than any yet discovered even at Mycenæ. The building contains no trace of anything Roman or Greek. Preliminary excavations at Kephala were begun on March 27.