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THE ARMOR PLATE FIASCO.

Once again, after many days of wearisome and profitless debate, the curtain has been rung down in Congress upon that perennial farce known as the armor-plate controversy. Were the issues involved less vital to the highest interests of the nation, this annual discussion would be, to the impartial and unprejudiced onlooker, simply a diverting spectacle—so curiously compounded is it of politics and prejudice, persistent misstatement, and unpardonable ignorance of fundamental and easily ascertained facts.

Unfortunately, the question of the supply of armor for our battleships, with which Congress has trifled so long, is of the most vital importance to a nation which is rapidly enlarging the field of its imperial interests, and assuming responsibilities which call for a vast increase in its naval and military strength. Every American that appreciates the momentous changes in our international policy which both involved and grew out of our war with Spain, realizes that the possession of a powerful and growing navy is now more than ever an absolute necessity. To such people the spectacle of the whole work of building up the navy being held up by the vociferous oratory of a small handful of congressmen is painful and alarming to the last degree—particularly when it is borne in mind that these very gentlemen who refuse to provide the weapons of war will probably be the most eager for blood-letting in any international quarrel that may arise.

Now that the Senate has given way, and the construction of our warships is to proceed, it is well to point out just how much delay has been occasioned by a controversy that has been altogether barren of results. In the first place, until a week ago, when the deadlock was broken, the construction of no less than nine first-class battleships and three armored cruisers was prohibited, and if the obstructionists had gained their point, the embargo would have lasted for yet another year. The first vessels to be affected were the "Alabama," "Illinois," and "Wisconsin," which were authorized in 1896, and, but for interference, would have been completed during the summer of 1899. As it was, an impossible limit of $300 per ton was put upon the price of the armor, the ultimate result of which was that the war Congress of 1898 was confronted with the spectacle of these three ships, ready for launching, but absolutely devoid of armor. Permission was now instantly given for the closing of contracts for armor, no price whatever being stipulated. Armor-plate, however, takes much time to fabricate, and Congress was presented with the first fruits of its folly in the shape of three costly but unfinished ships that could not by any possibility be available, even if the war were protracted beyond all reasonable possibility.

And thereby hangs a tale, the moral of which is so obvious as to warrant a recital, in the vain hope that some recalcitrant obstructionist may profit thereby. When the certainty of a war was upon us, instructions were given to a shipbuilding firm that had one of the unfinished battleships in hand to draw up plans for placing *wooden armor* upon the sides, barbettes and turrets, with a view to filling in the yawning gaps, for which, thanks to Congress, there was no plating available. The guns were to be placed aboard, and our gunners, snugly ensconced behind this painted sham, were to be sent out under the protection, at least, let us hope, of a merciful Providence. If it were not so painful, this incident would be positively funny; and the least we can hope is that the contemplation of that humiliating episode will effectually prevent its recurrence in a future emergency.

The total delay on the three ships under discussion has been eighteen months; on the three vessels of the "Maine" class, twelve months; while the closing of the contracts for the six vessels of the "Georgia" and "California" classes has been delayed for at least a year.

TWO REMARKABLE ACHIEVEMENTS IN CHEMICAL PHYSICS.

Before the London Royal Society two papers were recently read, the one by Sir William Crookes, the other by Sir W. Roberts-Austen, which, apart from the fact that they dealt with achievements of the utmost importance to scientists, illustrate how painstaking is the work of the modern scientific investigator and how delicate are the methods which he employs.

Sir William Crookes described his experiments in the analysis of the compounds of uranium, an exceedingly rare metal, which, Becquerel found, emitted rays that affected a photographic plate, even though an opaque object intervened. This remarkable property is even more pronounced in other metals, notably in radium and polonium, for which reason it was suggested that uranium rays were due to the presence of minute quantities of these more active metals in uranium. It was the object of the experiments made by Sir William Crookes to ascertain whether uranium was in itself capable of emitting light-rays, or whether its strange property was to be attributed to some other body present in the form of an impurity. His investigations proved that uranium is inactive when pure, that polonium, at least, is not the energetic substance, and that the rays are sent forth by an unknown element, not identical with radium, but so closely resembling it, that its detection is a matter of extreme difficulty.

In his analysis, Sir William Crookes used pitchblende (uranium oxide); for he found that it was more highly radiant than any other uranium compound; and should, consequently, contain the body sought in the largest quantity. He endeavored first to ascertain whether the property was most noticeable in any particular salt of uranium. But his experiments showed that all salts were active; that as the salt increased in purity the phenomenon was not so marked, and that extremely pure uranium did not affect a photographic plate. The natural inference was that uranium had not the property, and that the rays were emitted by some impurity in pitchblende. Polonium, Crookes determined, could not be the metal which he was seeking. Radium is more nearly coincident with the energetic substance; but the fine differences which he detected led him to conclude that the radiant property of pitchblende and other uranium compounds is to be attributed to the very slight admixture of an element still undiscovered, which can not yet be critically examined, because it cannot be obtained in quantities large enough for experiment.

The nicety of the method of investigation employed by Crookes, and the importance of the conclusions which he drew from his investigations, can be fully appreciated only by chemists. The significance of the work of Sir W. Roberts-Austen, on the other hand, will be more readily understood. Four years ago, Sir Roberts-Austen stated that if a column of lead be placed upon a column of gold, and the two metals heated below the fusing-point of lead, the gold evaporates, so that even after a period so short as twenty-four hours, traces of gold can be detected in the lower portion of the leaden column. In order to prove that at common temperatures also, the nobler metal gives off vapors which penetrate the baser body, he subjected the superposed metals to the ordinary heat of 65° F. for a period of four years. At the end of that time he found that the gold had diffused itself in the lead, and that the amount of gold thus diffused diminished as the distance between the two columns increased. He has not proven that gold evaporates without the presence of another metal; but he has certainly demonstrated that two metals may mingle without the application of extraordinary heat.

OUR PHENOMENAL EXPORTS.

An exportation of $40,000,000 worth of manufactures in thirty days is a record unparalleled for American manufacturers. That is the record for the month of April, 1900. The details of the April exportations, just completed by the Treasury Bureau of Statistics, show that the exportation of manufactures during that month was by far the greatest of any month in our history, and within a fraction of $40,000,000. This gives assurance that the exports of the fiscal year, which ends with June, will considerably exceed $400,000,000, and be nearly three times as much as a decade ago. This phenomenal increase in exportation of manufactures is especially striking when compared with the progress made by European nations, our rivals in the attempt to supply the world's market with manufactured goods. Great Britain's exports of manufactures show but slight increase since 1890, and an examination of the export record of the principal European countries fails to disclose an instance in which the increase has been as much as 25 per cent, while that of the United States, meanwhile, has been more than 150 per cent.

An examination of the details of our own exportation of manufactures shows that it is in the production, manufacture and exportation of metals that we seem to excel. The history of nations and peoples shows that great groups of people frequently excel in certain industries, and the growth of our exportation, as well as our domestic production of manufactures, seems to point to metals as our most successful line of work, especially at the present time. In 1889, manufactures of metals formed less than 20 per cent of our total exportation of manufactures, and in 1900 will be about 45 per cent of our exports of manufactures. The increase in exportation of metals and manufactures thereof in the decade 1889-1898 was 339 per cent, while the increase in the exportation of all manufactures in that time was but 110 per cent, and the increase in manufactures other than those of metal during that time was but 55 per cent. In this statement of the exportation of manufactures of metals, only those articles composed exclusively of metals are included; those made up in part of metals, such as railway cars, agricultural machinery, etc., being included in the other manufactures. The rapid increase in the exportation of manufactures of metals is shown by the fact that the exports of brass and manufactures thereof in 1889 were but $321,137, and in 1900 will reach $1,700,000; instruments for scientific purposes increased from $1,033,338 to $2,270,803, and in the year about to end will reach nearly $6,000,000; copper and its manufactures, which amounted in 1889 to $2,348,954, will be more than $50,000,000 in 1900; iron and steel increased from $21,156,077 in 1889 to $70,406,885 in 1898, while in the fiscal year 1900 they will exceed $100,000,000.

Another interesting fact developed by the examination of the figures is that the European countries, in which manufactures have been long established, furnish as satisfactory a market for our manufactured goods as do the countries where manufacturing has not yet been largely developed. In reapers and mowers, clocks and watches, sewing machines, bicycles, and the various manufactures of iron and steel, and many other articles of the higher grades of manufacture, the European countries, in which manufacturing plants and machinery and skilled workmen abound, furnish a market for a large share of our exports, thus failing to justify the expressed fear that a development of manufactures in countries where we are now seeking a foothold for our commerce would destroy their value as a permanent market.

In this attempt to show the growth of the exportation of each article in every direction, it has only been practicable to measure the growth by values, as the varying value of the units of quantity designated by a common name would prove confusing and misleading. A statement of the number of watches, clocks, sewing machines, typewriters, electrical instruments, mowers and reapers, carriages, articles of glass and china ware, builders' hardware, and miscellaneous articles of cotton and woolen goods, for instance, in which the value of units ranges from a few dollars to hundreds in a single class, would convey no information for comparative purposes and does not supply any facility for measuring the real growth of the industry or the commerce in it, as does the simple statement of total values by classes. On the other hand, the well-known fact that prices of nearly all classes of manufactured goods have greatly increased by reason of cheapened and improved methods of production renders a mere statement of values somewhat misleading in an attempt to determine the actual increase in the exportation of numbers or quantity of nearly all articles.

As already indicated, the largest growth in our export of manufactures is in that of metals. The largest class of manufactures of metals exported is that of iron and steel. In 1880 the export of manufactures of iron and steel was $14,716,524, and in 1900 will exceed $100,000,000, or more than seven times that of 1880.

In no feature of our export trade has there been a more remarkable growth during the decade than in rails for railways, especially those of steel. The total exportation of iron rails in 1889 was but 7 tons, and in 1898, 2,769 tons, the value rising from $240 in 1889 to $37,150 in 1898. In steel rails, however, the growth was even more remarkable, the number of tons exported in 1889 being 7,398, and in 1898, 229,782, while the value increased from $235,387 in 1889 to $4,613,376 in 1898 and in the fiscal year 1900 is likely to reach $8,000,000. This increase has been especially marked during the past three years, the exports of steel rails in the fiscal year 1896 being $540,797; those of 1897, $2,482,208; those of 1898, $4,613,376; and those 1899, $5,298,125; while the first ten months of the present fiscal year show a gain of about $2,000,000 over the corresponding months of last year. While this rapid increase is due to a generally increased demand, the countries showing the most marked growth in their purchases of steel rails from the United States are Russia, Canada, and Japan.

THE RAILROAD SYSTEMS OF ASIA.

The total length of the railroads in Asia is 30,000 miles, of which two-thirds are represented by British India. The Trans-Siberian alone has 5,800 kilometers. In China the different European and American syndicates have obtained concessions for about 3,000 miles of railroad, and these are for the most part in construction. The Chinese government possesses also about 300 miles of lines whose operation is now being carried out under good conditions, especially for the lines uniting Pekin to the port of Tientsin. Japan has no less than 3,100 miles of railroad, and the French colonies, which now possess but 250 miles, have more than 2,500 miles in construction in Cochin-China, Annam and Tonkin. The Dutch East Indies have a well developed system. Java alone having 1,000 miles. These figures are far surpassed by those for British India, whose system has a total length of 21,100 miles. Persia has as yet no railroad systems, but the Russian syndicates appear to be ready to profit by the monopoly which they have secured for the construction of railroads in that country. Turkey is adding a number of important lines of road to the 1,600 miles already possessed in Asia; the Franco-German line, of Bagdad, is one of the largest of these systems.

ELECTRICAL SUPPLY BY GAS COMPANIES.

BY ALTON D. ADAMS.

That the essential equipment in gas service is well suited to serve an important purpose in electrical supply has become apparent with the development of the gas-engine. A gas works ready to deliver a large supply of gas at any point in a wide and thickly settled area can operate in that area a number of gas-driven electric stations at a minimum cost. There are two very good reasons why such gas-driven stations can be operated with decided advantage by gas companies. One of these reasons lies in the fact that electric energy from these small stations can be sold for several times the price of the gas consumed in its operation. The other reason is due to conditions that make it possible to generate electric energy at such stations at a less sum per unit than with most other systems.

First consider the selling-price of gas consumed to drive dynamos and the market value of the electric output. For gas-engines of not less than 100 horse power, such as would be used at these small electric stations, a consumption of 18 cubic feet of gas, containing 700 heat units per cubic foot, is sufficient, per brake horse-power hour developed, at nearly full load. Direct-current dynamos, in sizes to compare with the engines just named, easily show a full load efficiency of 90 per cent. Each electrical horse-power output at the dynamo terminals requires, therefore, the consumption of $18 \div 0{\cdot}90 = 20$ cubic feet of gas in the engines. As the electrical horse-power hour, or 746 watt-hours, is very close to three-fourths of the kilowatt-hour, the latter requires $20 \div 0{\cdot}75 = 26{\cdot}7$ cubic feet of gas at the engine. In the largest cities, the average price per kilowatt-hour is about ten cents. Under similar conditions the average price of gas containing 700 heat-units per cubic foot is about one dollar per thousand cubic feet. At this rate, the 26·7 cubic feet of gas necessary to produce one kilowatt-hour at the dynamo terminals have a selling price of 2·67 cents. The product of the electric plant is, therefore, $10 \div 2{\cdot}67 = 3{\cdot}75$ times as valuable as the gas consumed in its engines. The 26·7 cubic of gas should supply five or six sixteen-candle power burners during one hour. The most common efficiency for incandescent electric lamps is 3·5 watts per candle, or 56 watts per lamp, so that one lamp-hour corresponds to 56 watt-hours. The gas-engine and dynamo deliver 1,000 watt-hours on a consumption of 26·7 cubic feet of gas per hour, so that this amount of gas, through the medium of the electric plant, supplies energy for $1000 \div 56 = 18$ incandescent lamp-hours nearly. In other words, gas, used in an engine to drive a dynamo, will operate three times as many incandescent electric lamps as gas-burners of equal candle-power. If the electric energy from the gas-driven dynamo be used in arc lamps, the illuminating effect produced from a given quantity of gas is still further increased. The actual average candle-powers of arc-lamps is about one-fourth of the nominal candle-powers. On a basis of their actual average illuminating powers, arc-lamps consume 1 watt of electrical work per candle-power. One kilowatt-hour of electrical energy thus produces 1,000 candle-power hours at the arc-lamp, while the 26·7 cubic feet of gas consumed to generate 1 kilowatt-hour give about $16 \times 6 = 96$ candle-power hours at the gas-burners. Gas used to drive an engine and dynamo supplies about ten times as much illumination at arc-lamps as it could give off if burned directly for lighting purposes.

It may now be considered whether the first cost and operating expenses of small electric plants, as part of a gas system, would be such as to offset the higher return on a given amount of gas. Many a gas system would, probably, supply a number of small electric generating stations along its main pipe lines, with increase of the latter or additions to the plant for gas production. This opinion is based on the fact that gas-producing equipment is not usually worked to its full capacity during all hours of the day, and that gas-mains have a very small flow during the greater part of each twenty-four hours. Moreover, an increase from the pressures of a few ounces per square inch, now common, to pressures of several pounds will materially multiply the possible delivery from present mains. Neglecting then, for the moment, any possible outlay for the increase of gas plants and mains, the first cost of electric stations supplied by these mains may be considered. There are some very obvious advantages of gas-driven over steam-driven electric stations. With gas-engines no boilers and no high chimneys are necessary; the handling of coal and ashes is avoided; only sufficient water is necessary to make good the evaporation due to cooling; and a generating equipment of relatively large capacity requires but a small space. These features of gas-driven electric plants reduce to a minimum the charges that must be made against them for real estate. The installed cost of gas-engines and dynamos, with all connections and accessories, should not exceed one hundred dollars per kilowatt of electric output capacity. During ten hours operation at full load, the value of the output from this gas and electric machinery would amount to one per cent of its cost, and four months of such operation, averaging ten hours per day, would give a gross return equal to the entire investment. It would probably prove desirable to install storage batteries with capacities of, perhaps, twenty per cent of the maximum rates of output at these gas-driven electric stations, to steady the station voltage, keep working engines fully loaded and supply the entire demand at times of minimum loads. These batteries, however, would reduce the necessary engine and dynamo equipment by an amount equal to the battery capacity, because all would work together during the short periods of maximum loads. The weight of the electrical conductors for a given electric pressure, rate of energy transmission, and per cent of loss must vary as the squares of the distances between stations and consumers. One distinctive feature of the plan here proposed is that these distances are short—much shorter than those over which present electric systems usually extend—and the cost of conductors will, therefore, be comparatively light. As an approximate figure, it may be said that the total outlay for the distribution system between these gas-driven stations and their customers should be about fifty dollars per kilowatt capacity of conductors at their maximum loads, on an average, or about one-half the expense for plant equipment. In order thus to increase the gross return on gas about 3·75 times, there must be added to fixed investment about $150 for each 26·7 cubic feet of gas consumed, for the increased return, per hour. The electric energy produced from these 26·7 cubic feet of gas hourly has a market value of $10 - 2{\cdot}67 = 7{\cdot}33$ cents more than that of the gas, and, allowing 3,000 working-hours at full capacity per year, the increase of revenue from the gas used in the electric generating and distributing equipment, at the estimated cost of $150, amounts to $\$0{\cdot}0733 \times 3{,}000 = \$219.90$. Labor in an electric plant driven by gas-engines is a comparatively small item, and much below the necessary amount of work to operate a steam and electric station of equivalent capacity. Whether these main facts, and the many minor ones bearing on the subject, warrant the supply of electric energy from numerous, comparatively small gas-driven plants must depend, in some measure, on the relative first cost and operating expenses of steam and electric plants for the same service.

The economical transmission of electric energy is a very real and pressing problem in the design and operation of extensive electric systems. The necessary substations for a high-pressure electric system require fully as much room and more equipment than would gas-driven electric generating stations of equal capacity. In batteries, the most expensive element of equipment, the electric sub-station requires more than the gas-driven plant of the same output, in order to lessen the load on the main station during times of maximum demand. Aside from the battery capacity and output, the electric sub-station must contain, per unit rate of delivery, unit capacity in rotary converters and a little more than unit capacity in transformers, making fully two units of electric machine capacity per one of output. Rotary converters are more expensive per unit of output than direct-current dynamos, while transformers are less so, making the machinery equipment for electric sub-stations about twice as expensive as the dynamos of a gas-driven plant for equal output.

Considering the additional requirement for batteries at electric sub-stations over that at gas-driven plants, and the double charge for electrical machinery, the total internal equipment of electric sub-stations and of gas-driven plants may be taken as about equal in cost for the same output. The local distribution system from each kind of station should cost substantially the same. The electric generating station with steam-boilers, high grade engines, dynamos, transformers, and high-pressure transmission lines, delivers not more than ten per cent of the energy contained in coal to the sub-stations, and derives a return only on what the sub-stations send out to consumers. In contrast, on the other hand, is the gas-plant and pipe system, distributing in water-gas fully 60 per cent of the contained energy in coal and more than 90 per cent of the energy in the oil consumed. Considering only the efficiency in transforming the energy of coal for each case, the gas-driven electric plant delivers $0{\cdot}60 \times 0{\cdot}20 \times 0{\cdot}90 = 10{\cdot}8$ per cent of the energy of coal as electric current, while the electric sub-station at its best can include in its output not more than $0{\cdot}75 \times 0{\cdot}15 \times 0{\cdot}90 \times 95 \times 90 = 8{\cdot}6$ per cent of the energy in coal consumed in the boiler-furnaces. These figures are based on efficiencies of 0·60 for the water-gas process, 0·20 for gas engines, 0·75 for steam-boilers, 0·15 for steam-engines, 0·90 each for dynamos and rotary converters, and 0·95 for large-station step-down transformers. No account is taken of the small losses in gas-mains and high-pressure electric lines from main to electric sub-stations. A much larger portion of the energy of coal can be transmitted through a gas pipe than through an electric cable, and the best locations for the generation of electric currents are close to the areas to be served.

PARIS EXPOSITION NOTES.

The work of installing the different exhibits in the annex to the Paris Exposition, at Vincennes Park, has been somewhat behindhand, but at the present time the park contains a series of buildings in which a number of exhibits of different kinds are being prepared. One of the most important of these is the building devoted to the Transportation section, this being an annex to the main building in the Exposition grounds. It contains the exhibits of locomotives, railway material and electric traction, and a considerable space has been allotted to each of the principal nations; France, Germany, England, the United States, Russia, etc., have important exhibits which include locomotives of different types, electric cars and trucks, air brakes, etc. In the Austrian section the Ganz Company has an electric car truck with two 25 horse power motors, and the Société Electrique of Winterthur, Switzerland, has an electric motor car of the type used on the inclined railway of Lyons. An electric locomotive of considerable size is that constructed by the Ateliers du Nord de France, the electric material being furnished by the General Electric and Thomson-Houston Companies. In the American section, the J. G. Brill Company, are putting in an exhibit of car trucks with and without car-bodies. The American Air Brake Company has a large exhibit showing its system, and a number of other exhibits are now being installed. When complete, this building will contain one of the most interesting collections of the Exposition. Near by is the section of ground allotted to the United States —in which several buildings and pavilions have been erected. The largest of these is the Machinery Hall, a long building with a main aisle and two side passages, giving a considerable floor-space for the different exhibits. The motive power for the machines was to have been furnished by a Ball engine and a dynamo of American make; the engine is now in place, but the dynamo is lacking, as it was sent on the "Pauillac." In place of this set, a Willans engine of the upright type and a Bullock dynamo of 150 horse power were brought over from England and rapidly set up. The different machine tools are run by small electric motors of different makes averaging 15 horse power. A large collection of American machine-tools is to be seen here, including lathes, planers, drill-presses, etc., of improved models; the Brown & Sharp Company has an interesting exhibit of tools, dies and gauges, and the Ingersoll-Sergeant Drill Co. show a number of air-compressors and drills. An overhead electric crane of the Shaw pattern has been installed in the building. Near by is a fine pavilion erected by the McCormick Company for its exhibits of agricultural implements, and another handsome structure has been built for the American bicycle exhibits; a number of these are already in place, but the building is not yet open to visitors. A number of windmills of American types have been erected in the section, and one of the interesting features is an oil derrick. Not far from the United States section is a building erected for various types of small engines, and here have been installed a number of gas and steam engines of various makes. Another building contains the Acetylene exhibits, and a few of these are already in place. In this part of the grounds is the Automobile building, which is to contain the vehicles of different countries, and in the neighborhood is a vast bicycle track of oval shape with an extensive series of tribunes; it is called the Vélodrome Municipal, and will be used for the numerous bicycle events which will take place during the season, in which the champions of various countries are to be represented. In the section allotted to the Army and Marine, special provision has been made for an exhibition of carrier pigeons. Near this is the Aerostatic park, which will have the necessary buildings for the balloons; here a number of ascensions and contests have been arranged for, and the most recent improvements in the art of ballooning will be shown. A space has been set apart for an extensive collection of agricultural machines, for which sufficient room could not be provided in the Champ de Mars. The groups of horticulture, aviculture, athletic sports, etc., have spaces assigned them. On an island in the center of the Lake Daumesnil is situated the Forestry building, which is an annex to that of the Exposition. A large tract of ground has been devoted to the agricultural and stock exhibits, which are in charge of the Minister of Agriculture. An interesting feature is a number of groups of workmen's houses, which occupy a considerable space; they are built after various models by France, Germany, Austria, Switzerland, etc., and show the most approved construction in wood, brick and other materials. On the main automobile track around the lake has been erected a line of iron poles supporting a double overhead wire for the use of the new system of electric motor wagons constructed by the Trolley Automoteur Company.