SCIENCE

FRIDAY, APRIL 18, 1913

CONTENTS

The Function of Research in the Regulation of Natural Monopolies: DR. EDWARD B. ROSA 579

The Ninth International Congress of Zoology at Monaco: PROFESSOR WM. E. KELLICOTT 593

The Tarr Memorial Window 595

Scientific Notes and News 596

University and Educational News 599

Discussion and Correspondence:—

On Methods of Teaching Modern Languages: PROFESSOR CHARLES HART HANDSCHIN. *Academic Freedom:* DR. HENRY LEFFMANN, PROFESSOR J. E. CREIGHTON .. 600

Scientific Books:—

Minchin on Protozoa: PROFESSOR GARY N. CALKINS. *Davis's Food in Health and Disease:* PROFESSOR W. H. JORDAN. *The Home University Library:* PROFESSOR T. D. A. COCKERELL. *Halsted's On the Foundation and Technic of Arithmetic:* PROFESSOR FLORIAN CAJORI. *Huygens's Treatise on Light:* H. C. 603

Special Articles:—

The History of Lost River: ROBERT W. SAYLES. *The Heredity of Color in Tumbler Pigeons:* DR. ORREN LLOYD-JONES. *A New Walnut:* DR. NEWTON B. PIERCE 611

Societies and Academies:—

The Anthropological Society of Washington: W. H. BABCOCK. *Philosophical Society of the University of Virginia:* WM. A. KEPNER 614

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE FUNCTION OF RESEARCH IN THE REGULATION OF NATURAL MONOPOLIES[1]

THE social and political unrest of the present day, which manifested itself strikingly in the recent presidential campaign, is of course due to more than one cause. Senator Root, in a notable speech recently delivered before the New York Chamber of Commerce, attributed this unrest in large measure to the mutual distrust and mutual misunderstanding existing between the leaders of the financial and industrial world, on the one hand, and the great body of the American people, on the other. To a large audience of bankers, merchants and captains of industry he said:

> There are hundreds of thousands of people outside our great industrial communities who think you are a den of thieves. There are hundreds of thousands of people who think the bankers and manufacturers are no better than a set of confidence men.
>
> We have before us now great and serious questions regarding the financial problems of the country, and this is what stands in the way of their solution: It is that the men who understand the finances of the country and the merchants engaged in great operations are under suspicion; great bodies of people will not accept what they say about finance. They will not accept what the experts say because they do not believe their motives are honest. . . . On the other hand, what is your attitude toward the people? There are many in this room to-night who down deep in their hearts believe that great bodies of the American people really want to destroy their business and confiscate their property. Now, neither of these things is true; but one misunderstanding leads to conduct which seems to justify another.

[1] Retiring presidential address before the Philosophical Society of Washington.

Senator Root then went on to say that there is nothing more important to-day than that by education and the spread of ideas such misunderstanding shall be done away with; that Americans shall interpret the spirit of popular government so that each shall be ready to do justice to the other, and every American shall desire the prosperity and happiness of every other American.

But while there is great force in what Senator Root says, it remains true that this social unrest springs in a measure from causes which the government can remedy.[2] The part which the government must play in our complex civilization is constantly increasing, and is immensely more important than in the simpler civilization of a century ago. In the early days the individual was much more independent, and each community was much less dependent on other communities than now. Society was simple, communication and commerce were limited, and relatively few laws sufficed. The twentieth century differs from the eighteenth in many respects, but in none more strikingly than with regard to the increasing complexity of business dealings.

The regulation and control of large corporations which have virtually secured the monopoly of particular industries is now receiving the attention of many of our leading scholars and statesmen, and the solution of the problem will be a triumph for popular government. The means that may be employed for this purpose are not so restricted as they formerly were. The public is becoming educated rapidly, and the constitution has greater capacities now than formerly.

STATE REGULATION OF NATURAL MONOPOLIES

While the federal government in the last few years has been striving to break up giant aggregations of corporations into their constituent parts, with the hope of getting these parts to compete with one another and so put an end to an undesirable monopoly, some of the states have been dealing in constructive fashion with another class of monopolies, and showing how they can be regulated and controlled to the end of conserving the best interests both of the public and of the stockholders. I refer to that very large and important class of corporations known as public-utility companies, chief among which are the steam railways of the country, city and interurban electric railways, gas and water companies, electric light and power companies and the telephone and telegraph companies. The federal government through the Interstate Commerce Commission has of course taken a leading part in this development, particularly with respect to the railways of the country, but the work done by some of the state public-service commissions, prominent among which are the commissions of Massachusetts, Wisconsin and New York, is of far-reaching influence and importance.

The attitude of the public regarding public utilities has been undergoing a profound change in recent years. Formerly a franchise for a street-railway or gas company, for example, was usually granted without compensation to the city, with few, if any, obligations on the company, with no control by the city over prices or service, and with extensions of the service into new territory optional with the company. Competition was sometimes sought by granting a franchise to more than one company, but generally such competition, if any, made the service poorer to the public as well as the profits less to the stockholders. If the business was profitable and the franchises valuable, city coun-

[2] In other words, the people acting cooperatively through their chosen representatives can remedy.

cils would be corrupted, if necessary, to get what was wanted. And, if the dividends were large, as they often were when no standards were set as to the quality of service and no limit set as to price, the capital would be sufficiently watered to keep down the dividends (capitalizing the value of the franchise, it was called). Occasionally a city became so dissatisfied with its gas or water or electric light company (either as to prices or service, or both) that in despair it built a new works, and two plants were operated where one, if rightly managed, would have served the public better.

ADVANTAGES OF A MONOPOLY

The change from this condition to the present (at least in certain states) is nothing short of revolutionary. It is now coming to be recognized that competition can not regulate rates in public utilities, and that one company can generally give better and cheaper service than two. It is a waste of capital and a disadvantage to a city to have two sets of gas or water pipes in the ground, or two sets of telephone or electric light wires and poles encumbering the streets. Having two telephone companies in a city forces a large proportion of their patrons to pay for both services; two street railway systems generally give less satisfactory service and fewer transfers than one would do. In short, these utilities are natural monopolies, and the highest efficiency and lowest rates are only possible when each one has the entire business of a given city or territory. So long as the right to regulate public service companies was denied, the idea of granting monopoly privileges was repugnant, and hence competition was encouraged with the hope of escaping the ill effects of unregulated monopoly. But now that the right and duty of regulating all public-service corporations is admitted by the companies themselves as well as by the courts, the ill effects of monopoly may be escaped and at the same time the beneficial results of economy and efficiency may be realized. To understand what effective regulation involves, we must consider the obligations imposed upon public utility companies, and the character of the service rendered by each.

When a community grants an exclusive franchise for a term of years or for an indefinite period to a corporation, with the right to regulate the quality of the service it shall render and the prices it may charge for such service, it undertakes a serious responsibility. The interests of the public must be safeguarded, but at the same time the interests of the company and its stockholders must be respected. A public-service commission, equipped with a full knowledge of the technical, commercial and legal aspects of the business, and endowed with a judicial spirit, will see that the following duties are fulfilled by each public-utility company in its jurisdiction:

1. To perform any duties especially prescribed by law.
2. To serve all who request service and make no discriminations.
3. To provide safe and adequate service.
4. To charge just and reasonable rates.
5. To fulfill its duties to its stockholders honestly and efficiently.[3]

REGULATION OF A GAS COMPANY

For example, a gas company receives a franchise to manufacture and sell gas for light, heat and power in a given city, for a

[3] This of course supposes that the commission has been given the necessary authority by the state legislature. Many of the public-service commissions were created as railroad commissions; and of these, some have had their functions extended to cover only a part of the duties mentioned above.

term of years, the city perhaps to have the right of purchasing the plant at the end of the franchise period. The quality of gas and the character of the service furnished, and the prices charged, are to be fixed by the public-service commission.

The commission must see that the company runs its mains into all the streets of the city, so as to give service to all; that uniform rates are charged and no rebates are allowed to favored customers; that service charges, if made, are reasonable; that the gas is of good quality, and as free from impurities as possible; that its heating value and candlepower are kept up to the standard specified; that the methods of testing and the instruments employed are up to date and satisfactory, and the persons doing the testing are competent; that the pressure of the gas is sufficient and not too great and does not vary enough to be dangerous; that gas appliances used are as safe as can be obtained, and connected in an approved manner; that the mains are properly located and properly protected from extremes of heat and cold; that the meters are kept in good order and tested from time to time as to their accuracy; that the prices charged are as low as possible, consistent with a reasonable dividend to the stockholders; that the books are kept in an approved form, so that the state of the business can readily be determined by the commission; that proper allowances are made for plant depreciation, or proper sums expended for upkeep; that no new stock is sold without approval by the commission, and that all dividends shall be from actual earnings, but that if actual net earnings are more than necessary to pay a reasonable dividend, the price of gas shall be reduced. This usually involves an appraisal of the company's property to determine whether the capitalization is fair. From time to time the specifications for the quality of the gas and the methods of testing must be revised; the question may arise as to what candlepower or heating value will give the best service under prevailing conditions; new methods of manufacture, new appliances and new uses for the gas will all bring up new questions; and the commission must be prepared to consider and decide upon all kinds of scientific, engineering and commercial problems as they arise in connection with the regulation of gas companies.

These duties are so many and so varied that one might suppose that it would be impossible for a commission to accomplish them all even for a single company, much less for all the gas companies in a state. If it had never been done, it would indeed appear doubtful. But these functions are being performed (at least in large part) so successfully in a few states that many of the other states are looking forward to doing it as soon as their commissions are prepared for the work. The gain from such regulation is not alone to the public, which pays for and uses the gas. The company is saved from unfair and hostile local legislation, which often forces resort to the courts, always an expensive and often unsatisfactory experience. The business is more stable, customers are better served and better satisfied, the credit of the company is often improved, new stock sells more readily and at higher prices, as the public knows the condition of the business and there is less risk to the investor. Stock manipulation is prevented, and those who profit by that process are the only ones to suffer.

Regulation of an Electric Light Company

Similar duties devolve upon a public-service commission with regard to other utilities. Electric-light companies are

regulated with respect to their schedule of rates; discriminations which are so frequent under ordinary circumstances must be prevented; wires, whether overhead or underground, must be run in such manner as to reduce the danger to the public; high-potential wires must be especially guarded to keep them from telephone and other low-potential wires; alternating current transformers must be grounded on the secondary side, and the grounds must be made according to approved specifications; the steadiness of electric potential and uniformity throughout a given city must be satisfactory; proper precautions must be taken to safeguard the lives of the linemen and other employees of the company; the meters must be frequently tested and provision made for extra tests on complaint; portable and station instruments must be tested; lamp renewals must be regulated and prices approved for other than free renewals and rules and regulations made (in the absence of local rules) with respect to street lights.

REGULATION OF OTHER UTILITIES

Street railways and interurban electric railways must be regulated with respect to kind and quality of cars; the speed of cars and car schedules; kind of brakes, headlights, doors and other safety appliances; the method of car heating and amount of heating required; the method of car lighting and the quality and amount of light that must be supplied; how the current is distributed from the sub-stations to the cars, and the variations in voltage permitted between sub-station and cars; how the railway current is returned from the cars to the sub-stations, in order that the resulting electrolysis may do the minimum of injury to gas and water pipes, lead-sheathed cables, and other underground structures; the repairs and upkeep of roadway and rolling stock; the fares to be charged and the conditions under which free transfers are issued; the wages paid employees and hours of labor; the conditions under which new stock may be issued; approval of plans for extensions or alterations of the system, etc.

Telephone companies must be regulated with respect to method of running their wires, so as to give the best and most reliable service possible under given circumstances; when and where wires must be put underground; the precautions to guard overhead wires against coming into contact with high-potential electric light or power wires; when and under what circumstances telephone and high-potential electric wires may be put on the same poles; the rates to be charged for different classes of service, both local and long distance; the service arrangements between different companies, the restrictions imposed by telephone companies respecting private exchanges and extensions; discriminations by a powerful company against smaller independent companies, etc.

Both the Interstate Commerce Commission and the state commissions deal with problems arising in connection with the regulation of the railroads, and these problems are numerous and of great importance. The first class of problems is connected with the fixing of freight and passenger tariffs, and discriminations in rates as between one locality and another or between one shipper and another. The second class of problems has to do with the operation of the road, with the safety and the adequacy of the service. This includes the question of the character of the roadbed and rails, the kind and quality of the engines and cars, the brakes and signaling apparatus, the kind of headlights and the candlepower and distribution of the light from the same; the heating, lighting and

ventilation of cars; the investigation of accidents; the weighing of freight and the testing of the scales, including the scales on which empty and loaded cars are weighed. These and many other questions may come before both state and federal commissions, but not all of them have been fully considered as yet by either. Similar duties pertain also to other utilities that are essentially monopolies, as telegraph companies, express companies, sleeping-car companies, water-supply companies, local express, transfer and cab companies. In so far as these utilities carry on an interstate business, they are also dealt with by the federal interstate commerce commission.

COOPERATION NECESSARY IN REGULATION

It appears from the above formidable, although incomplete, list of duties devolving upon a state public-utility commission that to fully measure up to its responsibilities would require a considerable staff of engineers, accountants and scientific assitants, besides its traveling inspectors and administrative officers. To decide many of the questions arising requires more technical knowledge than the experts either of the commission or the utility companies possess. Indeed, many of the questions can only be answered by extended researches carried out by scientists, engineers or statisticians working with the best of facilities. The interests at stake are in the aggregate so great that such researches ought to be made, and yet the cost would be too great for every state to do the work independently, or even for the richest of the states to undertake it alone.[4] The best way in which the work can be well done and kept up to date is for all the states to cooperate, and for the federal government to assist and coordinate the work. This is being done to some extent already, although comparatively few of the states as yet have commissions that are handling public utilities generally, and hence the work is only fairly begun. On the part of the federal government, the Interstate Commerce Commission and the Bureau of Standards are cooperating with the state commissions, the latter with regard to standards and engineering questions which fall within its province. Some of these questions may be mentioned briefly.

INSTRUMENTS AND STANDARDS

The instruments and standards employed in the measurement of heat, light and electrical power have been the subject of much study and investigation at the Bureau of Standards. The thermometers and pyrometers of various kinds employed in temperature measurements, and calorimeters of different types for use in measuring the heat of combustion of gases and solids, are calibrated and certified by the bureau, and standard samples of certified calorific value are furnished, so that the testing apparatus of public-service commissions, public-utility companies and consulting engineers will agree (or special tests be made if they disagree) and causes

[4] Extract from Professor R. T. Ely in his "Outlines of Economics," 1908:

"The tasks which confront such commissions are stupendous, and the expense of conducting their work, when it is properly conducted, is enormous. . . . On the whole, however, it is fortunate that the public have resolved to give this method of reform a thorough trial. It seems to be the next logical step in the evolution of natural monopoly, and does not appear to be attended with any grave danger. If it fails it will at least have trained up a corps of public servants thoroughly familiar with the operation of public-utility enterprises, and will at the same time have thoroughly convinced the people that there is no other alternative but public ownership and operation." This was written five years ago, and much progress has been made since then.

for dispute are thereby removed. The methods of testing with such apparatus have been studied by the bureau and sources of error in apparatus and methods determined. As manufacturing methods are developed and refinements in works control are introduced, greater accuracy in testing is required, and it is a great advantage to the industries to have uniform and reliable instruments, standards and methods.

The same may be said respecting the measurement of light and illumination. The candlepower of a gas flame depends upon the quality of the gas, the kind of burner used, the height of the barometer, the amount of moisture in the atmosphere and the degree of purity of the air in which it burns; hence, if the quality of the gas is to be determined (in part) by the candlepower given, it is necessary that the test be made under very definite conditions. The bureau has done considerable work on flame standards employed in gas testing, but much remains to be done in this respect. Photometric standards are supplied by the bureau for use in testing electric lamps of various kinds and colors, and gas standards are calibrated and certified. Thus, uniformity of value in light measurement is secured for the whole country, and indeed by means of international comparisons made by the bureau for the whole world, the international candle being the name of the unit of light universally employed in this country. Calibrations are also made of photometers and auxiliary apparatus. Similar uniformity, together with a much higher degree of precision, have been attained in electrical measurements. Electrical energy is sold by the kilowatt hour or the kilowatt year (or a combination of the two) and a large amount of testing is done by the companies and commissions to insure accurate measurement of the energy delivered. Here again uniformity and accuracy are promoted by having a national laboratory for calibrating and certifying standards and instruments, and settling such disputes as may arise from disagreeing measurements. A large amount of work has been done by the bureau to secure and maintain accurate standards and instruments, but much remains to be done, particularly with reference to the specifications of instruments and apparatus and the improvement of methods of measurement and testing.

In addition to its work on instruments and standards, the bureau has carried out other investigations which have a bearing on the work of the public-service commissions. One of these is concerned with the specifications of illuminating gas, and the methods of testing to be employed in controlling its quality.

REGULATION OF GAS COMPANIES

Among public-service utilities, none has been for so long a time and in so great detail subject to legal requirements and restrictions as the gas business. Such regulation is of course intended to insure good service. Many elements go to determine good or poor service, the principal of which (chemical purity, heating value, candlepower and condition as to pressure of the gas) are enumerated and defined more or less completely in many of the gas ordinances now in force, together with the tests that shall be made and the penalties for failure to meet the requirements. These ordinances are sometimes, therefore, very technical and contain detailed specifications. In other cases the specifications are very meager. In some cases old ordinances long since out of date, so far as their technical specifications are concerned, are still in use; in other cases, old ordinances have been extensively amended; in

still other cases entirely new ordinances have superseded old ones; in many cases no regulatory ordinances have ever been adopted. In some states possessing state commissions, the requirements have been fixed by the commissions. But in most states (and in all until recently) regulatory ordinances have been prepared and passed by state legislatures or city councils. The process of adopting such an ordinance is often long and painful. Suspicion, antagonism and often political considerations combine to make the negotiations difficult, and sometimes it amounts to a long-drawn battle. The representatives of the city endeavor to get all they can for the public, the company yields as little as possible. The result is generally unsatisfactory to both. Because the standard of performance demanded of gas companies in different cities and states was so different, and because so much difference of opinion existed among experts as to what could fairly be required of a gas company under given conditions, the Bureau of Standards took up about three years ago a careful study of the subject of state and municipal regulations of the quality, purity and pressure of illuminating gas supplied by gas companies.

INVESTIGATION CONCERNING REGULATION OF GAS COMPANIES

A compilation of all the state laws and city ordinances in force in the country was first made, and their technical requirements tabulated. A detailed study was then undertaken of the various features of such laws, and an attempt made to formulate a model law that should contain reasonable standards of quality, purity and pressure, and a reasonable set of operating requirements. In this study, a large number of the best informed gas experts in the country were consulted, and many gas plants visited. In this work the bureau has been assisted by the responsible officers and members of the technical staffs of gas companies and by members of public-service commissions, gas inspectors and consulting engineers. The bureau has endeavored to consider all sides of the various questions involved, and has of course received very conflicting opinions on some questions. It has been a source of great gratification to those conducting this investigation to see the fairness and broad-minded spirit shown generally by representatives of the gas companies in discussing questions that affected them so vitally. They have met a spirit of fair play by a corresponding willingness to reach just conclusions.

The results of this investigation were published by the Bureau of Standards, and the paper has had a wide circulation and careful study by those most interested in the subjects treated. Since its publication, the bureau has continued to study the subject, and is now preparing a revision of the first edition. The compilation of laws and ordinances will be revised and some important changes will be made in the model ordinance proposed. These changes are, however, being discussed very fully before publication, both with representatives of the public-service commissions and of the gas companies, the latter including a special committee of the American Gas Institute.

The position of the bureau in this matter, as in so many others, is advisory. It has no authority to enforce its conclusions and no disposition to suggest federal legislation or regulation. It acts as an unbiased coordinating agency, to formulate the results of its own and others' investigations and to give expression to the consensus of opinion of those best qualified to

express opinions on technical questions of great practical importance.

A second investigation (already alluded to) is in progress on the methods and instruments employed in testing gas for its heating value, its candlepower and its chemical purity, as well as in testing meters and measuring gas pressures. This will be embodied in a separate publication which will be frequently revised and kept up to date, in order to be as useful as possible to gas inspectors and engineers in determining whether gas meets the specifications under which it is sold.

A third investigation scarcely begun, but which is much needed and deserves extensive study, is on the safety and efficiency of gas appliances. Too many fatal accidents result from defective gas appliances, and the contamination of the atmosphere through imperfect combustion due to defective appliances is a serious matter, even when no fatalities result. This is a question in which cooperation of all the interests concerned can not fail to yield important results.

INVESTIGATIONS OF ELECTROLYSIS

Another important investigation carried out by the Bureau of Standards, which also concerns public-utility companies, is the damage by electrolysis produced by street railway currents flowing through the earth, upon gas and water pipes, lead-covered cables belonging to telephone, telegraph and electric-light companies, and the reinforced concrete foundations of buildings and bridges. Such insulated double conductor systems as those of New York, Washington and Cincinnati provide for the return of the current to the power houses without flowing through the earth, but most cities use the single overhead trolley, and permit the current to return in part through gas and water pipes and other underground conductors. Where the current leaves such metal conductors, the latter are corroded electrolytically, and in some cases holes eaten through, thereby interfering with the service and involving expensive repairs. Many remedies have been proposed, but as yet comparatively little has been done to cure the evil. The bureau undertook a thorough study of the question for the purpose of testing some of the proposed remedies and arriving at a solution of the difficulty, if possible, that could be applied generally. This investigation is not yet completed, but already valuable results have been reached and it is hoped that shortly information will be made available for the use of the street railways that will permit them greatly to reduce the volume of the currents flowing through the earth without unreasonable expense, and that will enable the public-service commissions to deal more intelligently with the question. The problem is becoming each year more acute, since the volume of electric current used is each year increasing as the traffic increases, and the damage produced is therefore increasing at an increasing rate. Many lawsuits have arisen because of this damage, and such litigation is expensive because of the large amount of conflicting expert testimony adduced and the long time consumed in the trials. Money expended intelligently in solving the problem generally yields better returns than money spent in litigation.

In England and some continental countries there have been rules on this subject which have served as a guide to the electric railways in building their roadways, and hence they have been saved very largely from the evil effects of electrolysis, although at a somewhat increased first cost. In this country the subject was neglected for years. In the absence of public-service

commissions or similar bodies to establish regulations, and no government agency to take the lead in the investigation, the matter has been entirely neglected in many cases until the serious damage resulting has made the question a very acute one.

LIFE HAZARD IN ELECTRICAL WORK

Another question affecting public-utility companies is the life hazard in electrical work. There are altogether too many preventable fatalities due to high-potential electrical circuits, not only to employees of the electrical companies, but also to the public. In many cases such accidents could have been avoided if the companies had taken greater precautions, either by instructing their employees more carefully, or providing them with rubber gloves and other protective devices, or having repairs made only on dead lines, or using more substantial and more expensive construction, or running the high-potential transmission lines on private rights of way instead of on the highway, or keeping the dangerous wires away from telephone wires and on separate pole lines, or taking still other precautions which experience shows are necessary. The long-distance transmission of power is being resorted to more and more, and higher voltages are being used than a few years ago would have been thought possible. One thousand volts is a dangerous voltage, but transmission at fifty to a hundred thousand volts is becoming common. As water power is utilized more and more, the country will finally be covered with a network of high-potential transmission and distribution lines, and it is a matter of vital concern that all reasonable precautions be taken in the construction and operation of such lines. So long as public utilities were regarded as private business and a company was free to make as much money as possible and invest as little as possible in its plant, the tendency was to economize unduly with respect to protective devices, and any construction that was more expensive than the mechanical or electrical requirements demanded was avoided. But when we regard railroads, electric light and power companies and telephone and telegraph companies not only as public utilities, but as quasi-public institutions, and permit them to charge enough to make a good profit, but to make the rates as low as good service permits, then it is seen that the public pays for the cost of protection, and it is entitled to require that every reasonable precaution be taken to safeguard human life. This latter is the view which is now becoming general, and the public-service commissions are therefore greatly interested in having rules and regulations worked out in such a way as to be capable of enforcement upon the electrical companies. On the other hand, the electrical companies themselves are anxious for such information. It is not necessary to make original investigations in every case; it is often a question of collecting and digesting the information already in existence, and with the cooperation of numerous agencies which stand ready to assist, work out a body of rules and regulations that will be as useful as possible. Congress has recently made a special appropriation to permit the bureau to undertake such a study of the life hazard in electrical work, and it is hoped that valuable results may be accomplished.

RAILROAD SCALES

Another investigation of great practical importance, in which the Interstate Commerce Commission and the Bureau of Standards are cooperating, is the investigation of the accuracy of railroad scales, especially car scales, for weighing freight.

Freights to the amount of two thousand millions of dollars are annually collected by the railroads on weighings made with scales, most of which are seldom tested and, except in three western states, never officially inspected. Numerous disputes and complaints could be avoided if the scales were officially tested and certified, and if provision were made for retesting on complaint. Certainly, it is as important to test large scales as small ones, and the cost of doing so is trifling in comparison with the enormous interests at stake.

LOCOMOTIVE HEADLIGHTS

Another subject with which some of the state commissions have dealt is the kind of headlights used on locomotives, their candlepower and reliability. In some states legislation has been enacted requiring a particular kind of headlight. It has been charged that such legislation in some cases has been inspired by commercial interests. In one state the commission issued a rule requiring a certain candlepower, but not specifying how it was to be measured or exactly what was meant. The railroads, contending that the order was ambiguous, impossible to comply with by one interpretation and undesirable by another interpretation, appealed to the courts. After a lengthy and expensive litigation the order of the commission was set aside. This case is cited to illustrate the need of technical information by state commissions before issuing mandatory orders, and also the hardship to railroads or other public-utility companies to be obliged to contest in the courts orders that work a hardship and which would not have been issued if full information had been at hand. There is great need of further investigation of the subject of headlights for use on steam and electric railways, to determine the best service that different types are capable of giving, and to formulate rules that could be enforced by the commissions. Some railroads economize unduly on the maintenance of headlights; in the interest of safety to the public, wise regulations should be in effect.

CAR LIGHTING

The lighting of cars (both steam and electric) is another practical matter that has not received the attention that it deserves. Most people read more or less on trains and street cars, and with many who ride a long distance to and from business this is their best time for reading. As a rule, however, the lighting of cars is insufficient and the arrangement of lights is often atrocious from the point of view both of the passengers who are not reading and those who are. Eyesight is too precious a possession and too easily injured to justify the continuance of poor lighting of cars. Better light is required than would be necessary if the cars were not moving. The problem is different on electric cars from what it is on steam cars, because in the former the current for lights comes from the same circuit that supplies the motors, and hence great variations occur due to the fluctuating voltage on the trolley wire. To secure better lighting, (1) a steadier voltage should be available, (2) better lamps should be used than are generally seen in electric cars, (3) a greater quantity of light should be available and (4) the lamps should be so shaded and so located as to keep the glare out of the eyes of the passenger, and yet give good illumination for reading. The immense importance of this subject can only be realized when one considers the millions of people who daily spend considerable time in steam or electric cars, and how much better the service would be if the cars were pleasantly and sufficiently lighted. The

public-service commissions have it in their power to effect an immense improvement in this respect, but first a thorough investigation should be made, with the cooperation of the railroads, to show what are the best methods to follow, and what it is practicable to accomplish with present resources.

HEATING AND VENTILATION OF CARS

Another question of great practical importance is the heating and ventilation of cars, including Pullman sleeping-cars. Any person who has sweltered in an overheated, unventilated lower berth of a sleeping-car (and who has not), will allow that there is great room for improvement. Surely the resources of American invention have not been exhausted in this direction, nor, indeed, with respect to heating and ventilation of day coaches. It is one of the functions of public-service commissions to see that the health and comfort of the public are kept in view by the utility companies, and if it can be made clear what should be done in this respect, the way to reform is open.

RAILWAY ACCIDENTS

Another line of work which deserves an immense amount of investigation and study, and cooperation between the states and the federal government, is the prevention of railway accidents. Much has been done and is now being done, both by federal and state agencies, and by the railway companies; but far greater sums of money might well be expended by the states and the federal government in a systematic investigation of all phases of this question. It is nothing short of a national disgrace that American railways should kill and injure so many more people than do the railways of European countries, even where the speeds are as high and the passenger traffic as heavy. Life is too cheap with us, and the penalty for disasters too slight. The causes of these accidents are partly physical and partly psychological; no doubt greater attention given to the subject of how to prevent both kinds of accidents would be abundantly rewarded.[5]

Other subjects deserving research could be named that fall within the province of the public-service commission, but enough has been said to show how important are their functions apart from the duty of fixing rates and preventing discrimination. These illustrations show how much better it is for the public as well as the companies that the commissions regulate by cooperating with and assisting the companies instead merely of dictating to them what they shall do or shall not do; that the scientist, the engineer and the statistician are more useful to them in their work than the lawyer; that the bar of public opinion is more effective than the courts in enforcing their decrees. Many of these utilities are operated by big corporations, owning scores of plants in many states; in the case of the telephone and telegraph, they are gigantic systems operating over the whole country. It is therefore important that the rules and regulations in the different states shall be as nearly uniform as possible. Hence, in order to reach wise and just conclusions, and to secure uniformity,

[5] A recent writer states that 19,377 more persons were injured on railroads in the United States in 1912 than in 1911, and commenting on the slight amount of scientific information that has been collected regarding the causes of accidents, he adds:

"The railroads of this country carry so many passengers and so much freight that in one year they are able to charge three billion dollars for the service. And yet it is admitted that no accurate engineering data showing the actual stresses which are set up in railway structures by locomotives and cars of different weights and moving at different speeds has ever been gathered."

it is important that the states cooperate with one another, and the federal government can serve as a valuable aid and coordinating force in this cooperation.

The results that are being attained in this way are only beginning to be realized. They will be of invaluable benefit, not only to the public served, but to the companies themselves, and to the cause of good government. With the utility companies under the control of business-like state commissions, the business is better managed,[6] discriminations in rates are eliminated,[7] the utilities are taken out of local politics and the possibility of pure municipal government in America is enormously enhanced.[8]

One of the best results of the method of regulation by public-service commissions is the publicity it secures of the affairs of the company and the confidence it establishes in the public mind in the various utility companies. The suspicion and distrust which Senator Root emphasized so strongly in his New York address is everywhere felt toward these companies when their affairs are kept secret, and especially when the service is poor and the dividends good. Controversies arise which sometimes degenerate into bitter and partisan feuds. Who can feel kindly toward the management of a street railway company if he is usually compelled to ride as a strap-hanger, or toward a gas company if the rates are excessive or he believes that his meter races, or toward any company that appears to regard its franchise as the deed to a private monopoly. If the service is improved or the rates reduced as the business grows more prosperous, the people as well as the stockholders derive benefits from success. The public soon realizes that utilities so conducted are in effect partnerships between the public and the stockholders, and are willing that the latter receive increased dividends with increased prosperity if the public is permitted to share the fruits of success. The sliding scale of prices for gas is a successful example of this system, but it is also realized in many cases where a sliding scale of prices has not been fixed in advance. The regulation of prices by a commission gives

[6] B. H. Meyer, speaking on the Wisconsin Public Utilities Commission at the Pittsburgh meeting (1908) of the National Municipal League, said:

"The utility law is working a revolution in business management. . . . Many of the utility companies have not been operated on a business basis; in fact, it is probable that a good many of the managements did not have the remotest idea as to the exact standing, from a business point of view, of the plant they were operating. Uniform accounting and rules governing the service and the regulation of rates, compel the adoption of business and scientific methods. This is resulting in nothing short of a revolution in management."

[7] The whole state of Wisconsin was literally streaked and plastered with discrimination in the rates of utilities, and in all the rest of the country, where the extent of the discriminations have not yet been determined, as they have been in Wisconsin, it is quite probable that discriminations similar in character and extent likewise exist.

[8] Governor McGovern has this to say regarding the utilities and politics in Wisconsin:

"Times were in Wisconsin when the railroads ran or tried to run the government of the state, and the minor utilities sought to boss the cities, towns and even villages. They contributed liberally to campaign funds, urged their supporters and lobbyists to become candidates for public office, and in close election districts colonized voters in the old conventional way. Now, one and all, they are in this sense absolutely out of politics. There is, indeed, no reason now why public-service corporations in Wisconsin should wish to dabble in public affairs. Their relations to the people of the state have been definitely and finally determined. They no longer have anything to gain or lose by intermeddling in politics, and apparently they have decided to retire for good. What the elimination of public-service corporations from participation in political campaigns signifies in the purification of public life, no one here needs to be reminded."

in effect a sliding scale, by which either the price goes down or the quality of the service goes up, as the success of the business justifies it. For want of a public-service commission in the District of Columbia, the Interstate Commerce Commission has recently been exercising the functions of such a commission with respect to the street railways, and with good effect. There is great need of a full-fledged public-service commission in the district, and it is hoped that Congress in its wisdom will respond to public sentiment and establish such a commission.[9]

How infinitely better is this method of regulation than the building of publicly-owned utilities to compete with private plants already in existence. For a state or city to say that it is impotent to regulate a public utility is a confession of weakness; but there is far greater difficulty in city control than in regulation by state commissions. Except, perhaps, in the largest cities, it seems much better to have strong state commissions, well equipped with technical assistants, than to have separate commissions for each city. And with the cooperation of other states and the federal government, any state commission can establish its work with only a fraction of the effort and expense required by those states that have pioneered the movement.[10]

Turning now to the great industrial and financial corporations popularly called trusts, the question suggests itself whether it is possible for the government to regulate them in a manner similar to the regulation of the natural monopolies we have been discussing, so that full publicity may be secured, the rights of the public may be conserved, and at the same time the rank and file of the stockholders will be protected from the vultures that often hover over the executive offices of such concerns. One can not say that it will be done as easily, but it is coming to be believed that the general method adopted in the regulation of public utilities is the right one, namely, less dependence on law and the courts, and more dependence on engineers, statisticians and business experts; that the government should prescribe affirmative duties for the giant corporations, and not merely negative ones; that a constructive policy that would benefit both the business concerns and the public they serve should be sought, rather than a retrograde policy that is no benefit to the business and does no good to the public. If such regulation could be realized, and consolidations and promotions in business could be limited to such as would benefit both the public and the stockholders, and not merely big financiers and promoters, it would be a notable achievement in our political as well as economic history. It would assist mightily in the peaceful settlement of industrial disputes and in the bringing about of a better understanding between capital and labor.

It is just as reasonable to expect the government to perform this function of regulation of monopolies as to expect it to adjust international disputes by arbitration rather than by war. It is not socialistic, but rather the reverse, for it is the alternative of state ownership. In Germany the cities are great business concerns operated by business men for the benefit of the people, and as such they are models for the whole world. They own and operate most of the public utilities themselves, and do it well, and hence the necessity of public regulation is there less

[9] A public-utility commission for the District of Columbia has been established by Congress since this address was delivered.

[10] Writing in 1908, Professor Ely said: "States having commissions empowered to enforce uniform accounting will constitute great economic laboratories in this connection during the next quarter of a century."

felt, although it has been practised for many years. But in this country, municipal ownership has been less successful, except in the case of municipal water supplies.

There have been three stages in the modern history of natural monopolies. In the first they went unregulated, being operated for the profit of the owners and exploited for the benefit of financiers. In the second stage, regulation was by legislation and lawsuit. In the third, regulation is by commission; the regulation is more complete, as well as more intelligent, and cooperation and publicity are keynotes of the method.

The large industrial corporations which have virtual monopolies, are mainly in the first stage, although some are in the second. Whether they will finally come to the third stage, and be regulated by the methods now applied so successfully to natural monopolies, remains for the future to determine.

If state regulation of natural monopolies becomes as general within a few years as it promises to be, and if it is as successful generally as it has been in the few states which took it up first, it will solve the problem of public utilities and largely solve the problem also of good municipal government.

The signal success of the Wisconsin Commission was largely due to the influence of the University of Wisconsin. In its personnel and methods it was a scientific commission, and entered into its work with the spirit of investigators. Its spirit and its methods have been adopted by some of the other state commissions, of which a large number have been created recently and are now taking up their work.

If the administrative officers of the commissions are assisted by scientists, engineers and economists, and the work is done in a judicial spirit, as new problems being taken up as a scientific research would be, the states and federal government acting in full cooperation, with the experience of each available to all—if the work is done in that way we may be certain that success will be sure and permanent.

EDWARD B. ROSA
BUREAU OF STANDARDS

THE NINTH INTERNATIONAL CONGRESS OF ZOOLOGY AT MONACO

UNDER the presidency of Prince Albert I. of Monaco, the congress was formally opened in the beautiful Museum of Oceanography on March 25. In his opening address the prince, after referring to the basic importance of the study of marine life and the conditions under which it exists, for one who desires a reasonable conception of the problems of biology, spoke of the prime value of the study of zoology as an aid in the solution of many of the problems confronting human social groups. He very cleverly pointed to the Principality of Monaco as a community where the life of the people is illumined by the light of science, and where the climax of all the activities of the state is a noble scientific institution devoted, not only to the investigation of the deep sea and its life, but to the application of the facts thus discovered to the daily life of the people.

For the reading of papers the congress was organized into eight sections, which, with the number of titles on the program of each, were as follows:

I. Comparative Anatomy and Physiology. 32 titles.
II. Cytology. General Embryology. Protistology. 25 titles.
III. Systematic Zoology. Behavior. 26 titles.
IV. General Zoology. Paleozoology. Zoogeography. 13 titles.
V. Oceanic Biology. Plankton. 8 titles.
VI. Applied Zoology. Parasitology. Museums. 15 titles.
VII. Nomenclature. 9 titles.
Sub-Section VIII. Entomology. 10 titles.

Three general sessions were held, upon the