SCIENCE AND THE GOVERNMENT[1]

By Senator H. M. KILGORE

A LARGE number of scientists have recently visited the halls of Congress, and have talked to some of the people's representatives in Washington. I feel, therefore, that I am perhaps only making a return visit when I appear before you this evening. I think it has been a good thing, and a healthy thing, for the scientists and the politicians to get to know each other better. The urgency of the times has forced us together, and I hope that the acquaintance will develop into a lasting and fruitful relationship.

There may be some scientists here this evening who want to know why the Government is concerned with affairs of science. I want to quote you a sentence from the writings of George Washington, who died in 1799. Washington believed, and said, that the "arts and sciences are essential to the prosperity of the state and to the ornament and happiness of human life."

The Founding Fathers believed that the Government should sponsor scientific research, and they incorporated into the Constitution a clause to the effect that the Congress should provide for the common defense and promote the general welfare. It is under the general-welfare clause that most of our peacetime research has been inaugurated. Expeditions and surveys have been sent out to explore and examine the national domain, and this examination has continued in greater detail as the various sciences developed.

Military necessity early called for Federal support of research. The first Federal research agency was for military ordnance and was established during the War of 1812. Three war-time research agencies were created during the Civil War, six during World War I and 12 during World War II.

Between wars there has been a consistent growth of Government research agencies for the general welfare. The first Federal grant in support of peacetime research as such was made in 1836, when steamboats were constantly blowing up and causing one disaster after another. In an attempt to remedy this situation, the Government made a grant of $10,000 to the Franklin Institute to find out the reasons and try to remedy them for the safety of steamship passengers.

The Department of Agriculture, an agency of research for farmers, was established in 1862. The Weather Bureau was established in 1890, the National Bureau of Standards in 1901, and I could name many other scientific agencies which have helped do the things which common citizens and taxpayers could not carry out alone.

With the increase of industrial activity in the twentieth century, the Government's participation in research was also accelerated, mainly in agriculture, conservation, reclamation, mining and forestry. Industrial development of the automobile forced the Government into research on roads. The nation's stake in the development of the airplane led to government-financed technical advances by the agencies of aeronautical research. Airport engineering developed largely during the depression. A logical development in the use of natural resources in a region is the applied research done by the Tennessee Valley Authority.

As science grew in importance, its recognition in the structure of the Government at a high level has been urged repeatedly. The National Academy of Sciences in 1884 recommended a Department of Science. The Congress, in 1903 and again in 1908, recommended a more "rational correlation" of Government scientific work. President Roosevelt's Science Advisory Board in 1933 and again in 1935 urged a permanent scientific advisory organization.

My own strong interest in Federal scientific activity dates from my early investigations as a member of the Senate War Investigating Committee headed by Senator—now President—Truman. Our studies in 1941 and 1942 of the mobilization of our resources showed weaknesses in the use of scientific data. In the synthetic rubber program, for example, a number of false starts were made because of the lack of adequate data in the hands of responsible government agencies.

In the fall of 1942 I introduced a science mobilization bill, and the Senate created within the Military Affairs Committee a special subcommittee of which I have had the privilege of serving as chairman, to study the scientific and technological problems of the war effort. Many of the objectives of better organization and enlargement of wartime research which have been set forth by the committee have been achieved, under the War Powers Act, by administrative action.

When the defeat of the Axis was imminent, the committee focused its attention upon the problems of the reconversion of research activity from war to peace, and the maintenance of high levels of scientific research in the postwar years necessary for our national security and welfare. The committee's studies of the Government's research functions and recommendations for the postwar era were embodied in the

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committee reports of January and July of this year. Our major conclusion, which closely paralleled that of Dr. Vannevar Bush's committee studying the problem for the Executive Branch of the Government, was that the Federal Government should greatly increase support of science, particularly in the basic sciences, in health and medical research, national defense and other research fields of recognized public interest.

Both the studies made for the Legislative and for the Executive Branches of the Government found that science is playing an ever more important part in the life of the nation, and that increased funds are needed to finance the nation's scientific activity. It appeared that for non-commercial-type research, whether for basic science or for such applied science as medical research, the sources upon which we have relied in the past, notably private philanthropy, can not meet the need in the future. It was accordingly recommended that public funds be used to create a widespread wealth of skills, ideas and facilities as an investment in national prosperity and peace.

During October, our subcommittee held public hearings on bills embodying the recommendations for increased peacetime support of science and providing for the creation of a Federal scientific foundation. Senator Warren G. Magnuson of Washington and I jointly heard more than 100 witnesses from all sections of American life, including many eminent specialists who testified on the need for such a foundation and the problems involved in its creation. With a single exception, these witnesses, representatives of industry, agriculture, labor, veterans groups, governmental agencies and scientific and educational groups and institutions, urged the creation of a Federal scientific foundation.

During the past two weeks I have been analyzing the testimony. The hearings have provided a public record on the basis of which recommendations can be made to Congress, and on which Congress can act with every assurance that it is meeting a vital national need in an effective manner. Let me give you a short summary of the testimony urging Congress to create a Federal science foundation to finance increased scientific activity:

(1) The witnesses believed that support of science was an essential of any national defense program.

(2) They believed that such support would make manifold contributions to the national welfare, particularly in public health, cultural development and the technical development of regional resources.

(3) A considerable number of witnesses pointed out that the foundation would contribute to international understanding and cooperation, and would help to avert another war.

(4) As to the functions of the foundation, those who spoke of it at all were unanimous in their agreement that basic or fundamental research should have government sponsorship. Widespread support was given to the proposition that the social sciences should be represented, as well as the physical and biological sciences.

(5) There was almost unanimous agreement that the foundation should support scientific training through a federal-aid program of undergraduate scholarships, postgraduate and postdoctoral fellowships.

(6) A great many witnesses urged that the foundation should maintain an up-to-date roster of scientific personnel.

(7) All witnesses agreed that the freedom of the individual working scientist must be maintained. Some were afraid of "political control" of science, but were reassured by other witnesses who pointed to the freedom of scientists working in Government departments and agencies.

(8) A majority of witnesses agreed that the foundation should coordinate research financed by the Government. The best way to do this, they agreed, was through voluntary joint planning and full exchange of information.

(9) And, finally, it was generally agreed that the foundation should promote the widest possible dissemination and utilization of scientific discoveries and techniques.

These are the things that you and your colleagues told me and the other Senators in Washington recently. I am not a scientist and I will not pretend that my approach to this problem is identical with yours. Yet it is my firm belief that the needs of the American scientists and of the American people, part of whom I have the honor to represent in Congress, are identical. I have become convinced, and I think many of my colleagues are convinced, that the free and unrestricted development of basic scientific research is such an important part of our potential national resources that we can not afford to neglect it. I feel that in order to discharge my responsibility to my constituents and to the people of America I am obliged to do whatever I can to encourage the growth of basic scientific research.

Now what does this mean? Will it be adequate merely to increase the funds available for scientific research? I think not.

There are, of course, many ways in which federal funds could be used to support American science. During the last five years I have given this matter much thought. I have considered many alternatives, and in each case I have abandoned them in favor of a National Science Foundation.

For instance, we could simply appropriate funds to each of the 48 states and tell them that they are to be used to support science. In effect, this would necessitate the establishment of 48 state science foundations.

Or we could make appropriations direct to each of the colleges and universities of the country in proportion to their enrolments. Then, instead of 48

local science foundations, we would have hundreds. I doubt, and believe you doubt, that such schemes would result in equally effective programs of research in national defense, health and medicine, and other fields of national interest.

Or again, we could make appropriations for nonprofit institutions which would, in effect, include private research foundations such as the Rockefeller, Sage or Carnegie foundations. Although I have the greatest respect for the purposes and practices of those and similar great organizations, I can not bring myself to believe that the American people would want, or Congress would defend, this manner of expending government funds.

Finally, we could appropriate federal funds directly to the National Academy of Sciences or its operating organization, the National Research Council. I assure you that this possibility has received serious consideration. The reason for not following this procedure is that, although these agencies were established by an Act of Congress and by Executive Order, they are not true Government agencies but have a quasi-public status. I shall discuss this point later.

An entirely new Government agency is needed. It is needed not only to provide the necessary federal support for science, not only to assure that the funds are spent on programs related to national welfare, but because science itself has now become such an integral part of government. I believe that you scientists want and deserve more than a government dole for your research.

I do not feel that the Government should tell you what to do or that the proposed Federal agency should exercise scientific judgment and attempt to make decisions which can only be made by the individual investigators. No, I am not proposing that you pay for these funds by giving up that freedom without which true scientific research would soon cease to exist. I think I can best explain what I mean by reference to the urgent scientific problem of the day—atomic energy. This problem is not only a major *scientific* problem but also the most important *political* issue of the day. You know better than I what this problem has meant to the scientists who have worked on the atomic bomb. These men received tremendous financial support from the Government. They did their job and they did it well, but it was a one-way affair. They were hired by the Government to do the job, but were given no opportunity to have a voice in what would be done with the new knowledge that they produced and applied. And now these men—and I applaud them for it—are making every effort to find some means of making their voices heard.

Science has reached such a stage of development that we must expect huge and far-reaching developments to come out of our laboratories. If we accentuate this process by increasing the financial support given to scientific research, the scientists will be continually faced with a similar situation. What is the solution? I propose that the Government not only give the scientists more money and better laboratories; I propose, too, that the Government make a place for the scientists in its very structure so that, as scientific knowledge advances, we shall also provide for a voice for the scientists. I think scientists deserve it, and the country needs it.

The need for bringing more scientific men into the Government is a critical part of the problem of the proposed Science Foundation. The foundation simply can not be administered by laymen. Its entire operation requires the scientific insight and knowledge which only the trained scientists can contribute.

Now it has been argued that we can not solve this problem by bringing scientists into the Government to operate this agency. It has been suggested by some that, instead, we shall have to depend on the part-time assistance of a scientific board who will hire administrators to run the foundation for them. I think, however, that the Government needs more than the part-time services of scientists. I think that we need some of you in Washington all the time, and one of your jobs should be to run the Science Foundation.

I know that this is something of a new departure for scientists. I know that it is a great deal to ask of a man who has spent a lifetime building up a career which is in many ways far removed from matters of public administration. Yet, without the full-time services of men who understand the scientific laboratory from the inside, any scientific foundation is doomed to failure. This issue can not be avoided. Many scientists have said at our recent hearings that the proposed Science Foundation must be under the control of scientists. With this, I heartily agree.

Science must have, and must have *now*, a full-fledged Government agency run by scientists. I think that this is necessary because, without it, the Government scientific activities can not be properly guided.

I will not discuss further the major areas of agreement revealed in the testimony. This evening I shall take the opportunity to discuss with you those aspects of the proposed foundation in regard to which there is a lack of general agreement or in regard to which misunderstanding exists. These include:

(1) The best form of organization for the proposed foundation—and here the principal discussion concerns the top management.

(2) The best way to assure in the legislation creating the foundation the full publication and free dedication to the public of the results of federally financed research.

(3) The best way to deal with the human—the social and economic problems which scientists can help solve.

Before final congressional action can be taken to create the needed foundation, agreement must be reached on these features. I believe that the extensive public record provides an adequate background for intelligent legislative action on these moot points. Before discussing them in detail, let me say a word about the manner, and the degree of precision, of the results which must be obtained.

Legislators—like scientists—must seek not only yes and no answers, but must also make determinations within practicable limits. In the various scientific disciplines, methods have been arrived at for achieving the necessary degrees of precision. Similarly, in Congress, we have an elaborate process for achieving results with the degree of precision appropriate to legislative action.

A bill introduced by a member of Congress is seldom voted on in its initial form. First through public hearings, then through deliberations of the committee and of the chamber as a whole, it is shaped toward its final workable form. Even after its enactment, its practicable application is reviewed annually when appropriations are made. Further, Congress can—and often does—modify the original enabling legislation by subsequent amendments based on the year to year experience of the agency. It is in the light of this process that we must seek to create for the new foundation an initial organizational structure so designed that it will have the greatest possibility of successfully accomplishing its purpose.

If we agree, then, that a National Science Foundation is needed and that the financial support of this foundation must come from federal funds, let us turn to a consideration of the problem of how the foundation should be administered in order that its functions may best be realized. Before attacking this problem directly, permit me to digress into a brief discussion of just what a Government agency is, noting where it differs from a private corporation whether of the industrial or institutional variety.

In order to appreciate the unique characteristics of a Government agency, let me ask each of you to imagine yourself for a moment a member of the Congress of the United States. As the elected representative of a segment of our people, I am sure you would feel, as I do, a heightened sense of responsibility to see that all agencies of the Government are operated not only in an efficient manner but in the best interests of the nation as a whole. From such a vantage point I am sure you would realize how very vigilantly we, as the members of Congress, seek to protect the rights of all the people in the enactment of any legislation involving the appropriation of taxpayers' money. Thus, in establishing a Federal agency to which we commit ourselves to make annual appropriations, one of the thoughts uppermost in our minds is that the agency be a true servant of all the people; and that, even under the most unfortunate selection of administrative personnel, we must protect the public from the possibility that the agency may become the instrument of special-interest groups, which, as you may know, are rather plentiful in our democracy. It is for this that the *sine-qua-non* of any Government agency is that its powers be vested in full-time Government employees whose principal responsibility is their public function, and who have severed all previous connections with private financial interests. From the Government standpoint it is unthinkable that the powers of the proposed National Science Foundation be vested in a board of non-compensated persons, whose principal responsibilities would lie in some other direction, as some scientists have so urgently and so honestly recommended. This is not to say that we, the trustees of the taxpayers' money and interests, impugn the integrity of those scientists who might be appointed to such a board. It is to say that we feel under the highest obligation to assure the people of the United States that under no conditions, at any future time, could the foundation conceivably be regarded as the agency of any special group.

Many scientists testified in the hearings and many have written to me personally that they are convinced of the superiority of the board form of organization. I respect the sincerity of their testimony in this matter and believe I understand why their analysis of the situation leads them to prefer this form of organization. Most scientists have spent their lives in universities and have worked with or under research foundations administered by a board of trustees or directors. In most instances, these groups of men are appointed or elected to serve as trustees of certain funds which private philanthropy has bequeathed. As trustees of these funds, it is their duty to assure that the funds are spent for the purpose or purposes specified in the bequest. In order to utilize the funds, the board of trustees establishes an operating agency, *i.e.*, a university or foundation, and then selects and hires an administrative officer who in turn selects and hires the technical operating staff. But note that it is this highly trained operating staff which carries out the actual work of the organization. The board of trustees simply meets from time to time, reviews policy, and in approving budgets gives its approval or disapproval to the programs proposed by the operating staff of the organization.

A foundation under a single administrator will have a board of trustees, and the board of trustees appro-

priate for all Government agencies is the Congress of the United States. Congress can not delegate its constitutional responsibilities or turn them over to any subsidiary board of trustees, no matter how distinguished its members may be.

Let me again emphasize that the success of any operating organization, whether a private industry, a university or a government agency, depends primarily on the quality of the technical personnel which makes up its operating staff. It is not the Board of directors or the trustees which do the scientific work of a university or a foundation; the same holds for the proposed National Science Foundation. The foundation will succeed only if, after its establishment, we are able to staff it with the very ablest scientists in the United States.

It will be the business of the foundation to administer a large segment of federally sponsored research. Just as the business of the Federal Trade Commission is carried on by full-time Government employees with the training and experience in economics and financial transactions, the National Science Foundation must be administered by a staff composed of first-class scientists devoted to the public service. And unless there are enough able scientists in this country who recognize the importance of this job of administering scientific activities, and unless such men are willing to accept full-time jobs on the staff of the National Science Foundation, it can not succeed in carrying out the functions which our recent hearings show to be so greatly needed. Now that science has come of age, there must be those among you who are willing to forego the role of the working scientist to accept the challenge of a new career in the administration of scientific research. I do not know how large a staff it will have to be. In the bill S.1297, we have specified only a full-time administrator, a deputy administrator and a director for each of the separate divisions. Obviously these men will need many assistants in all fields of science. I do know that we can not expect the business of the foundation to be properly conducted by part-time employees who come to Washington a few days every month and then go back to their regular jobs. The activities of the proposed foundation will be so manifold and so important that they must be administered ably, continually and efficiently if the foundation is to succeed. I say to you frankly, if I were not convinced that there are those among you who are willing to accept the challenge of these tasks, I would not support the legislation to establish a Science Foundation.

If we agree that the National Science Foundation must be a Government agency, rather than a quasi-public foundation receiving Government appropriations, and if we agree that the powers of such an agency must be vested in full-time Government employees with no responsibilities other than to science and the nation, we must still face the problem of the best form of top administration. This problem is not unique to the proposed National Science Foundation; it is a problem which concerns us every time a new agency is established. Many experiments in administration have been tried in an effort to find the best answer to this difficult problem.

There are two general solutions to the problem of top administration. Both are known to be workable solutions, yet both have very real advantages and disadvantages. The first solution is that of having the President appoint, with the advice and the consent of the Senate, a single administrator in whom all powers of the agency are vested. This administrator in turn selects and hires other Government employees as his divisional chiefs. These in turn select and hire subordinates, and thus there is created an operating organization with a direct line of responsibility centering in the single administrator. This form of organization works. It is used in all governmental departments and in certain of the bureaus of these departments. It has also been successful in many agencies of the executive branch of the Government.

The advantages of the single administrator form of organization are clear-cut. All responsibility for the success of the agency is immediately identifiable. If the work of the agency is successful, the administrator gets the credit. If the work of the agency is unsatisfactory, the administrator gets the blame, and if the work is too unsatisfactory we get a new administrator! Every one working in the agency knows the lines of responsibility under which he works. This in general has been found to make for more efficient administration.

The disadvantages of the single administrator form of administration are simply stated. It involves placing tremendous responsibilities in the hands of one man. If he is a good man, that is, if he selects able administrative assistants and accepts their counsel in arriving at decisions, he will run a good agency. On the other hand, if the wrong man is selected and he fails to build up an efficient operating organization, and furthermore if he refuses to seek and accept advice as to the manner in which the agency should be administered, he will fail as the responsible individual. Fortunately, because he is immediately identifiable, he can be removed by the President and a new administrator appointed.

The alternative general solution which has been found successful in the administration of Government agencies is the board or commission form of organization. In this case the President, with the advice and consent of the Senate, appoints several full-time

Government employees to constitute the top administrative organization. In some cases, members of the commission elect their own chairman, and in some cases the President designates the chairman. In general the board or commission form of administration has been found to be successful when it has judicial functions, such as passing on rate questions, determining rights as between individuals or corporations. All the members of these commissions or boards are full-time Government employees.

The advantage of the board or commission form of administration is that it permits combining the wisdom of several at the top level of administration. In establishing the size and characteristics of commissions, the President and Congress attempt to include representatives of all interested groups in the hope that the special biases or predilections of the individuals will be cancelled out in the deliberations of the board, thus resulting in decisions more nearly reflecting policies in line with national welfare.

The disadvantages of the board form of administration can also be simply stated. It is a somewhat more unwieldy form of administration, and it is more difficult to identify the responsibility for satisfactory or unsatisfactory policies, decisions and programs. In case the program of the agency becomes too unsatisfactory it is necessary to replace at least a majority of the board before achieving the needed correction. As you can see, this requires considerably more time, and I may say replacement is less likely to happen than in the case of a single administrator.

I assure you that many of us have given a great deal of thought as to which general form of administration will be most satisfactory for the proposed National Science Foundation. As I see it, there are three general alternatives:

A. A single administrator, appointed by the President, with the advice and consent of the Senate, in whom will be vested sole authority for operating the foundation.

B. A board of three to nine full-time members, appointed by the President, with the advice and consent of the Senate; at the time of appointment one of the members of the board shall be designated by the President to serve as chairman.

C. A single administrator appointed by the President with the advice and consent of the Senate and a top advisory board of five to fifteen representative members, appointed by the President, to serve in a part-time capacity while continuing their regular professional work with universities, industries or other organizations.

These three general alternatives seem to be the only feasible forms of top administration for the proposed foundation. I honestly believe that, with the selection of the proper persons, any one of the three forms of administration would work and work effectively in the best interests of both science and the nation. I would be willing to join my colleagues in recommending that the bill about to be reported out provide for any one of these three alternatives. In the light of our general discussion of the problems of administering Government agencies, however, I wish to explain why I personally believe Alternative C represents the best possible set-up for the proposed foundation.

I prefer a single administrator, not only because it promises to make the administration of the foundation more efficient, but primarily so that all of us—the President, Congress, scientists and the public—will know at all times exactly who is responsible for the program of the foundation. Because of the manifold facets of science, I can not conceive a board of even nine men adequately representing all its interests equally and fairly. A single administrator, because he would operate under the spotlight of both public and scientific scrutiny, would not dare to omit an essential type of scientific endeavor from the program of the foundation.

On the other hand, I do not feel that this administrator should be asked to carry on the work of the foundation without the advisory service of the country's ablest scientists. Although I feel that any competent administrator would seek and utilize the advice of such an advisory board, even though he were not legally required to do so, I believe the law should include this feature and be so written that this advisory board could never become a mere perfunctory body. It is for this reason that we propose to require at least monthly meetings and to give the advisory board the privilege of direct access to the President and Congress. Under this organization, an administrator would not necessarily have to act in accordance with the advice of his advisory board, but, if he failed to do so, he would be obligated to defend to the public any alternative actions. It seems to me that we can depend upon such continuous public surveillance of the activities of the foundation to assure a minimum of unwise administrative action.

I believe that an advisory board, on which it is quite appropriate for citizens to serve on a part-time basis, would enable the foundation to secure the part-time assistance of any of the country's most able working scientists. To my mind the foundation would be more vigorous and would keep more closely in touch with the important problems of all fields of science if this advisory board were composed of men regularly engaged in administering or doing scientific work in the country's academic and industrial laboratories. It is for this same reason that we have recommended part-time advisory committees for each of the divisions. Even though we are able to hire the most able scientists as Government employees to staff the operating organization, they will require the continual stimula-

tion of outside working scientists if they are to continue to serve as effective members of the organization.

The composition of the top advisory board, it seems to me, might reflect the interests of the country as a whole. Of course, this means that scientists should be included on the top board but, at the same time, it means that industry, agriculture and labor might also be represented. They are the consumers of the fruits of scientific research. By contrast, at the divisional level, I would conceive the advisory committee to be made up almost exclusively of scientists. It is at the divisional levels that the truly scientific decisions of the foundation will be made. Not only must the Government employees who staff these divisions be competent scientists in their own right—they must have the advice of leading scientists both in and out of the Government laboratories in the planning and administration of the divisional programs.

In brief, I prefer alternative C because I believe it will result in the best administered foundation and provide the best opportunity for scientists to assist in the operation of the foundation both as Government officials and as advisers. And if we provide for limited single terms of office for advisory committee members, the foundation will retain a vitality which can not be achieved under any other form of administration.

As I have said, the other alternative forms of organization will probably work; and, if in the judgment of those who support the foundation, one of them should be clearly preferred, I should not be adverse to incorporating it in the legislation.

I think that we can all agree that the single administrator without an advisory board (Alternative A) is a much less adequate proposal. On the other hand, if full-time board or commission has certain advantages but, frankly, I think they are outweighed by inherent disadvantages. In the first place, a full-time board would mean that several of the nation's outstanding scientists would have to give up their present positions to become board members. Furthermore, unless we give such board members unlimited terms of office, it means that scientists appointed to the board would have a difficult time in returning to non-governmental positions after a term of board service. Over a period of years these board members would, as a group, become so identified with the foundation that they would assume a defensive attitude toward its program. It seems to me far better that we provide the foundation with a proven, efficient operating type of organization, but protect it from becoming bureaucratic by providing for a truly functional advisory board which would continually aid, scrutinize and criticize the program of the foundation.

Now, a few words on the utilization of research findings. The pure scientist is interested only in the truth, and we are agreed that the foundation should support a very strong program of basic research. But we must not overlook the fact that the group support of science is based on the belief that all knowledge of nature will eventually result in making our existence safer and more satisfying. There may be a few scientists left who are content with the mere discovery of a new fact or law—but I think that most scientists realize that even the most abstract discovery may have a world-shattering impact on civilization and society.

In spite of the fact that applied science has contributed increasingly to the destructiveness of successive wars, I am sure that most scientists are honestly concerned that their work be used for the welfare of mankind—not for its destruction. The problem of assuring the widest and wisest utilization of the fruits of research is indeed a knotty one. Because it is enmeshed with almost every phase of our culture and economy, I shall not pretend to solve it here this evening. I do, however, wish to comment briefly on the so-called patent issue associated with this science legislation.

Let me make one point clear, because it seems to have been misunderstood by some. The proposed legislation is in no sense a patent reform. It is not patent legislation, and it in no way changes the overall picture with respect to privately developed or privately owned patents. This was stated clearly by Commissioner Ooms, of the Patent Office, in the course of the hearings on these bills.

My bill to establish the National Science Foundation includes a provision to standardize the handling of all patentable discoveries growing out of all federally financed research. It is no more than an attempt to give the Government a logical and business-like policy, which, at the moment, simply does not exist. Your fellow scientists working in governmental laboratories need such a uniform policy. It is not equitable that a scientist working in one bureau receive the commercial rights to inventions which he makes and an equally competent fellow scientist in a different bureau be compelled to dedicate his patents to the public. Yet that is the situation as it exists to-day.

Granted that a uniform policy is desirable, to be of most value to science and the nation it must also be equitable and based on sound business principles. After much consideration and discussion with representatives of all interested groups, I am convinced that this basic policy should be one of full publication and free dedication of all findings, including patents, which result from federally financed research.

This conclusion is based primarily on two general lines of reasoning:

(1) A fair proportion of scientific discoveries are not patentable. Therefore, why should a scientific worker be rewarded because he happens or chooses to work on projects which yield results that can be commercially exploited? Would there not be a danger that good men would be enticed to work in the applied, rather than the fundamental, fields of research? Is there not the further danger that the possibility of patentable results would tend to conflict with free intercourse among scientists and the full publication of research? In other words—is not the policy of free dedication the one which most nearly conforms to the ideals and practices of scientists themselves?

(2) What policy with respect to patents represents good practice for the Government? Industrial laboratories require that patents developed by employees be signed over to the industry. This, they argue, is only fair to the stockholders, whose money not only builds the laboratories but also pays the salaries of the employees. It would seem that the policy of public dedication is dictated by the Government's responsibilities to its stockholders—the taxpayers. To put the question another way. why should the taxpayer contribute to the cost of a development and then later be forced to pay for it again because of a royalty which the manufacturer pays to the holder of the patent? Or worst yet (and this is not unheard of), would it be fair to the taxpayer if a patent based on Government-sponsored research should become the exclusive property of a company which refused to use it because it would not be to its economic advantage? Or can we defend the exclusive patenting of an important medical discovery? So—we have proposed the basic policy of full publication and free dedication.

However, it has been necessary to provide for certain exceptions to this basic policy. Certain types of developmental work needed by the military services can best be carried on in industrial laboratories, which are better equipped for some special kinds of work than non-profit laboratories. Such industrial laboratories, because they contribute a plant, an experienced staff and "know-how" to the project, are deserving of at least a portion of the commercial patent rights resulting from the research. Assuming this to be the case, we have made provision for exceptions to the basic policy of public dedication by stipulating that in those instances where the head of a Government agency (including the foundation) finds that a research project can not be carried out properly except in a private industrial laboratory, he is empowered to include special clauses in the contract to provide for a fair disposition of any resulting patent rights. However, to keep this provision from being unwisely used, it has been provided that each agency be required to publish the details of all such contracts within thirty days after executing them. In this way, I believe that we can be sure that special clauses will be used only when they are really in the public interest.

I wish that there were time to speak of the many other aspects of our problem. But there is one point to which my thoughts keep returning: Science is today at a crucial turning point, and we must find the road which will lead to its continuing advancement. If we are to find this road, we can not define science too narrowly. There are some who sincerely believe that the proposed legislation should exclude research in the social and economic fields. I wonder if this can wisely be done.

If studies of public health are found to involve social factors, should the foundation be prohibited by statute or hampered by lack of duly constituted research personnel and facilities from pursuing investigations in this direction? I am sure you will answer this question as I have answered it—in the negative. If surveys of our resources reveal the need to examine economic problems that are intimately related to their development, is the foundation to stop short of its goal because Congress failed to make provisions for economic research?

Congress would not meet its responsibilities to the public if it excluded research in those fields which are most directly concerned with human welfare. There is, I may say, reason to believe that a majority of scientists feel this way, for one of the scientific organizations represented here to-night testified at the hearings that two thirds of those members of its governing body who responded to a questionnaire on this point favored inclusion of the social sciences in the foundation. Probably these activities should be set up in a separate division coordinate with the natural sciences; but they should be there carrying their fair share of the burden of research.

We stand at the threshold of a new era of achievement in scientific research. Almost every field of science has at hand the basis for rapid advance. Even some of the less spectacular by-products of scientific research can be the starting point of new experimental methods and even of whole new sciences. The production, in significant quantities, of new radioactive isotopes opens up a vast new field of research in biology, chemistry, medicine and industrial sciences. I have listened enough to your colleagues to realize that the production of a radioactive isotope of carbon can make possible experiments which will plunge deep into the innermost secrets of physiological processes and of the behavior of organic chemicals. Yet, as one of the witnesses at our hearings pointed out, the cost of such isotopes is so great that only Federal support

can supply the funds which will make such experiments possible. Here is a clear case where the very progress of science depends on the establishment of Federal support of basic research.

John Quincy Adams, in his first message to Congress in 1825, said: "In assuming her station among the civilized nations of the earth it would seem that our nation has contracted the engagement to contribute her share of mind, of labor and of expense to the improvement of those parts of knowledge which lie beyond the reach of individual acquisition." Now, as the boundaries of knowledge are being rapidly pressed back, it is our obligation to provide the means for solving those problems "which lie beyond the reach of individual acquisition." I do not mean that we must find a substitute for the labors of individual scientists, for this is the very essence of scientific research. Rather I believe that the Federal Government must provide whatever the individual scientist needs to make his efforts bear fruit.

I know there are some who say that science has now become such a terrible instrument of destruction that we must now call a halt to its advancement. No scientist can support such an idea, and history has shown that every such attempt to restrain human progress is doomed to failure.

Rather I think that we must face the issue squarely. If we have now learned how to harness the very forces of the sun, if we can now achieve such scientific miracles, then certainly it lies within our power to solve the economic and political problems which threaten to turn our knowledge into destructive channels. This is an obligation which all of us must meet. And you, as scientists, have begun to play an ever-more critical role in this great project. I think that you and, indeed, the people of our nation should be proud of all the men of science who have begun to find the means of explaining to the world that scientific progress and human progress can not follow separate paths.

It is my firm purpose to do what I can, within the Congress, to provide for all science and for all scientists the support which they need and deserve. The proposed Science Foundation can be a national investment that may yield undreamed-of returns in knowledge, in wealth and in human progress. But its immediate value may be dwarfed if it will also make science a more vital part of our nation's heritage—if it draws scientists ever deeper into the stream of democratic advance that has made our nation great.

OBITUARY

LEONARD SALOMON ORNSTEIN

PROFESSOR L. S. ORNSTEIN died at Utrecht, Holland, in May, 1941, after an illness of several months. In November, 1940, all Jewish teachers were dismissed by the Nazis, and he was forbidden to visit his laboratory. An earlier illness returned, and he passed away before the full pressure of Nazi persecution was exerted against the Jews. His wife and three children, aided by many of his associates and former students, were able to live "underground" and have survived the war.

A student of Lorentz, Leonard Salomon Ornstein obtained his degree at Leiden in 1908. For a few years he occupied a lectureship in mathematical physics at Groningen. In 1914 he was called to the University of Utrecht as a successor to Debye in the chair of theoretical physics. Ornstein's interest soon turned to the experimental side of physics, and after serving as acting director for several years, he was appointed in 1925 director of the physics laboratory at Utrecht, giving up the professorship of theoretical physics, and devoting all his time to the direction of the research activities at the institute for the rest of his life. In 1931–32 he was rector of the University of Utrecht.

Ornstein's work, the extent of which may be judged from well over 200 publications, lay chiefly in problems of kinetic theory and in measurements of light intensity. In the first field, he contributed to the theory of Brownian movement and to the properties of liquid crystals. In the second, he secured his greatest fame for his development of the methods of photographic photometry and for their application to the measurement of spectral intensities. Under his direction, the photographic plate became an instrument of precision. In his laboratory was developed the well-known Moll microphotometer. Standards of light were established accurately to further the photographic methods.

Ornstein and his students made use of the exact quantitative measurement of spectral intensities in a wide variety of problems. As examples may be mentioned isotope ratios, accommodation coefficients, excitation functions of spectral lines by electron impact and diffusion coefficients. One of the early applications led to the empirical development of the familiar sum rules of multiplet intensities. From measurements of the intensities of band spectra it was established that some arcs are regions of thermal equilibrium at very high temperatures. This led not only