should lead to the perception of noise rather than tone.

The interesting thing, from our present point of view, was the rapid growth of the loudness of the noise as the current was increased. The patient was asked to compare the noise with a sound produced by an acoustic stimulus led to his normal, unoperated ear. He adjusted the loudness in his normal ear to match the loudness of the noise in the operated ear. This simple procedure disclosed a startling fact. The growth of loudness was many times steeper under electrical than under acoustical stimulation. The exponent of the power function under electrical stimulation was, in fact, of about the same order of magnitude as that observed when a 60-cycle current was applied to the fingers.

Many interesting questions are raised by these measurements, but one implication is clear. The "compression" observed in the normal response of the auditory system to a sound stimulus is apparently not an affair of the central nervous system, for if we bypass the ear and stimulate the auditory nerve directly, we detect no compression. Rather, there results an "expansion" in the subjective response. Apparently, therefore, it is to the end organ itself that we must look for the mechanism of compression that governs the slow growth of loudness with acoustic intensity.

So it appears that, with the aid of scales constructed for the measurement of sensation, we may have disclosed a fundamental difference between two transducer mechanisms. The transduction of sound energy into nervous energy is by way of an "operating characteristic" that somehow compresses the over-all sensory response. The transduction of electrical energy into nervous energy seems to follow quite a different rule. To be sure, this outcome is but a trifle in the vast and relentless contest to unwind the tangle of nature, but it testifies, in simple example, to the profit that may accrue from measuring the "unmeasurable" (*19*).

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News of Science

Science Education Legislation for 1958

Congressional hearings are now being held on proposed legislation for additional Federal support for education, especially science and language education, in the United States. There are two major bills. On 28 January, Senator H. Alexander Smith of New Jersey, for himself and 10 other senators, introduced a bill entitled the "Educational Development Act of 1958" (S.3163). This bill contains the recommendations that were presented in President Eisenhower's Education Message to Congress on 27 January. An identical bill (H.R.10278) was introduced in the House of Representatives by Carroll D. Kearns of Pennsylvania. On 30 January, Senator Lister Hill of Alabama, for himself and 26 other senators, introduced S.3187, a bill entitled "The National Defense Education Act of 1958." A companion bill (H.R.10381) was introduced in the House of Representatives on the same day by Carl Elliott of Alabama. Several other bills dealing with educational matters have been introduced, but this analysis will be confined to the two major bills. All of the Senate bills have been referred to the Committee on Labor and Public Welfare, and all of the House bills to the Committee on Education and Labor.

For purposes of identification in the following discussion the bill introduced by Senator Smith and Congressman Kearns will be referred to as the Administration bill; the one introduced by Senator Hill and Congressman Elliott, as the Hill-Elliott bill.

Purposes. Both are omnibus bills with broad objectives. The purposes are similar, but there are some interesting differences in wording.

The purposes of the Administration bill are "to encourage and assist in the expansion and improvement of educational programs to meet critical national needs through the early identification of student aptitudes, strengthening of counseling and guidance services in public high schools, provision of scholarships for able students needing assistance to continue their education beyond high school; strengthening of science and mathematics instruction in the public schools; expansion of graduate programs in colleges and universities, including fellowships; improvement and expansion of modern foreign language teaching; improving state educational records and statistics; and for other purposes."

The purposes of the Hill-Elliott bill are "to strengthen the national defense, advance the cause of peace, and assure

the intellectual preeminence of the United States, especially in science and technology, through programs designed to stimulate the development and to increase the number of students in science, engineering, mathematics, modern foreign languages, and other disciplines, and to provide additional facilities for the teaching thereof; to promote the development of technical skills essential to the national defense; to assist teachers to increase their knowledge and improve their effectiveness; to inform our scientists promptly and effectively of the results of research and study carried on in the United States and throughout the world; and for other purposes."

If the memory of some of the people on Capitol Hill is correct, the Hill-Elliott bill is the first in the history of the United States which specifically states the intention to ". . . assure the intellectual preeminence of the United States. . ."

In addition to the provisions described below, the Administration has recommended a very substantial increase in the budget of the National Science Foundation to enable the Foundation to increase its support for basic research, graduate fellowships in the sciences, and, in particular, improvement of teaching and education in the sciences. The proposed budget for science education is five times as large as the current appropriation. The Administration has adopted the position that programs that are confined to science and that involve direct negotiations with institutions of higher education are the responsibility of the National Science Foundation, while programs that include all fields of study, and those that are operated through state departments of education, are the responsibility of the U.S. Office of Education. With the exception of the science information service provisions of the Senate version of the Hill-Elliott bill, the bills discussed below concern programs that fall entirely within the responsibility of the Office of Education. Proposed expansions in the National Science Foundation programs will be discussed in a later issue of *Science*.

Student guidance. The authors of both bills recognize the importance of providing improved student counseling and guidance concerning immediate and future educational and vocational plans. To encourage the states to establish guidance programs or to expand existing ones, both bills offer matching funds, on a 50-50 basis, in support of state plans that meet the approval of the U.S. Commissioner of Education. The Administration bill offers up to $1.25 a year for each pupil in grades 9 through 12 (estimated total, $90 million in 4 years). The Hill-Elliott bill offers $15 million a year on a permanent basis, to be matched by the states in the third and succeeding years but not in the first two years.

Recognizing that there are not now enough well-trained counselors to provide the guidance service that is desired, both bills would authorize the Commissioner of Education to contract with colleges and universities to run special institutes for training counselors. In the Administration bill, the amount of money for this purpose is left to the discretion of Congress. In the Hill-Elliott bill the sum of $6 million a year is given and the stipend for persons attending summer institutes is set at $75 a week plus $15 a week for each dependent.

Scholarships. Both bills provide for a substantial undergraduate scholarship program. The Administration bill proposes an appropriation of $7.5 million the first year, with that much added each year until in the fourth and final year $30 million is appropriated. The Office of Education estimates that this money will provide about 10,000 new scholarships each year for four years. The Hill-Elliott bill calls for 40,000 scholarships a year for six years. In both cases, the scholarships are good for four years if the holder continues to do satisfactory work in college.

In both cases, money for the scholarships is to be allotted to state commissions in accordance with plans prepared by these commissions and approved by the U.S. Commissioner of Education.

Selection of scholarship winners is, in both bills, to be on the basis of ability. Scholarship holders may attend any accredited college or university that accepts them and may work in any field, but in both bills it is indicated that emphasis should be given to students who show particular interest and ability in science and mathematics. The Hill-Elliott bill gives equal emphasis to modern foreign languages.

There is an important difference in the nature and purpose of the scholarships proposed in the two bills. The Administration bill proposes to award a certificate to all winners and to allot an amount of money which is determined by the student's resources and needs. The purpose is to aid needy students to attend college, and scholarships are intended only for students who demonstrate need. The amount is not in any case to exceed $1000 a year and is expected to average about $750. In the Hill-Elliott bill, the scholarships are of $1000 a year and are independent of need. The scholarships are intended to recognize merit, and the authors hope that this program will stimulate intellectual interest and achievement widely throughout the high schools of the nation.

The Hill-Elliott bill includes several provisions which are not in the Administration bill. One is for an additional 20,000 scholarships for the first year (1958–59) for students who are already in college, or who have been in college, and who therefore are not eligible for the regular scholarships.

The Hill-Elliott bill also authorizes a loan fund of $40 million a year from which approved students could borrow up to $1000 a year. Repayment would not begin until one year after the date on which the borrower ceases to be a full-time student. Interest, at 2 percent, will not begin to accrue until the beginning of the time for repayment, nor will interest accrue while the student is in school, in the armed forces, or employed as a teacher at elementary, secondary, or collegiate level. The recipient of a loan who later becomes a teacher will have the loan canceled at the rate of 20 percent for each complete academic year of teaching.

An additional feature of student support, included in the Hill-Elliott but not in the Administration bill, is the proposal that there be appropriated $25 million a year, which will be made available to institutions of higher education that apply for grants. This money can be used to pay 50 percent of the cost of employing undergraduate students for work that is connected with the operation of the institution and, to the maximum extent possible, related to the field of study of the student. Again, special consideration is to be given to students of superior capacity and preparation in science, mathematics, engineering, and modern foreign languages.

Fellowships and graduate education. Both bills contain provisions for the support of graduate students, and in both the emphasis is on giving graduate training to students who are likely to become teachers in institutions of higher education. After that agreement, however, there is an important divergence in the two proposals. Under the Administration bill, grants would be made to individual universities. Each university would grant fellowships of such number and size as are recommended by the university and approved by the Commissioner of Education, and would be entitled to a grant of not more than $125,000 a year from which it could either (i) retain up to $500 a year for each student awarded a fellowship, or (ii) pay half of the additional salary and other costs chargeable to the establishment of a new graduate program or the expansion of an existing one. The amount for fellowships is not stated in the bill, but was given in the President's message as $2.8 million in the first year, rising to $12.6 million in the fourth year.

Under the Hill-Elliott bill, there would be awarded, on a national basis, 1000 fellowships the first year and 1500 addi-

tional ones in each of the next five years. Each would be tenable for up to three years. Fellows could attend any university that admitted them and would receive stipends of $2000 for the first postbaccalaureate year, $2200 for the second, and $2400 for the third. In each case, an additional allowance of $400 a year for each dependent would be authorized, as would an allowance of up to $1000 for payment to the university to help meet the costs of instruction.

Improvement of teaching. Both bills contain several provisions for the allocation of funds to state educational agencies or directly to educational institutions for the improvement of teaching. The Administration bill would authorize $15 million a year to state educational agencies, apportioned among the states in accordance with the number of school-age children, to pay one half the cost of approved programs for supervising instruction in science and mathematics; for improving science and mathematics curricula, instructional methods, and equipment; or for improving the undergraduate eduation in science and mathematics of students who expect to become teachers of those fields. To be eligible for grants, programs must either be new or be expansions of existing programs. They may be for elementary or secondary education.

The Hill-Elliott bill provides for allocation among the states of $10 million a year, on a matching basis, for paying or supplementing the salaries of science, mathematics, and modern foreign language consultants. In the Administration bill, the already mentioned provision for grants for supervision of the teaching of science and mathematics would allow the employment of consultants in these fields.

The AAAS can take a particular interest in these provisions, for both bills recognize the value of consultants similar to those sponsored by the AAAS in Nebraska, Oregon, Pennsylvania, and Texas for the past two years. These experienced and expert teachers have served as consultants in mathematics and science to high school teachers whom they have helped, on an individual basis, with their subject matter and teaching problems. This program has been enthusiastically endorsed by teachers and superintendents in the four areas in which the AAAS has (with funds provided by the Carnegie Corporation and with the cooperation of the state university and the state department of education) been able to establish these programs.

The Administration bill would also authorize $150 million a year to be allotted among the states, on a matching basis, to allow the employment of additional qualified science or mathematics teachers and to increase the compensation of science and mathematics teachers. This money might also be used for the provision of laboratory and other special teaching equipment. To be eligible for a grant, a plan would have to be approved by the state educational agency, and any teacher whose compensation is paid or increased under such a program would have to meet minimum qualifications set by the state.

Provisions under the Hill-Elliott bill are somewhat different. Forty million dollars a year would be made available for allotment to the states on the basis of a formula that takes into account both the size of the school-age population and the income per school-age child in the state. These funds would be available, on a matching basis, for approved projects to acquire facilities for the teaching of science and mathematics.

The Hill-Elliott bill would make an additional $40 million a year available for improving science and mathematics teaching facilities of institutions of higher education.

The Hill-Elliott bill also authorizes $75 million a year for payments to teachers who enroll for advanced study in summer sessions, and $25 million a year to teachers who enroll for advanced study in extension courses offered by institutions of higher education. Stipends for summer session work would be $75 a week plus $15 a week for each dependent. Stipends for extension study would amount to $7 for each day on which a course is attended plus tuition and university fees. Money for these purposes would be apportioned among the states, would be available for both elementary and secondary school teachers, and would not require matching by the states. Teachers in all fields of instruction would be eligible, but special consideration would be given to those who wanted to undertake advanced study in science, mathematics, and foreign languages and it would be required that the advanced study be in a subject matter field appropriate to the teacher's responsibilities.

Foreign language instruction. In the Hill-Elliott bill there is recognition of the special need to improve the teaching of modern foreign languages, and various provisions (scholarships, fellowships, teacher training, and so forth) apply to foreign languages as they do to science and mathematics.

The Administration bill devotes a special section to foreign languages and contains some provisions that are not found in the Hill-Elliott bill. Through grants or contracts with institutions of higher education, the Commissioner of Education is authorized to support short-term and regular session institutes for advanced training of teachers or prospective teachers of foreign languages, and to pay stipends to teachers attending these institutes. The institutes would be similar in character and purpose to those in the fields of science and mathematics that the National Science Foundation has supported for the past several years.

The Administration bill also authorizes the Commissioner of Education to make matching grants to enable institutions of higher education to establish and operate special centers for the teaching of those modern foreign languages for which the Commissioner determines that adequate instruction is not already available in the United States and for which the Federal Government, business, industry, or education needs teachers or translators.

To support the provisions described in the two preceding paragraphs, the Commissioner of Education is authorized to make studies of the need for training in foreign languages and to conduct research on methods of teaching and the development of specialized materials for language teaching.

Congressional citations. As a device for increasing student motivation, the Hill-Elliott bill authorizes the Commissioner of Education to award to the top 5 percent of high school graduates medals and scrolls bearing the inscription, "Congressional citation for outstanding scholastic achievement." No similar provision occurs in the Administration bill.

Vocational education. The Hill-Elliott bill provides $20 million a year, on a matching basis, for increased assistance to the states for training technicians in essential skills.

Science information service. The Senate version of the Hill-Elliott bill includes provisions for establishing a science information service within the National Science Foundation. The parallel bill in the House of Representatives does not contain these provisions, nor does the Administration bill. The reason for this one difference between the House and Senate bills is not disagreement over the desirability of a science information service but rather a difference in the operations of the House and Senate. The Senate bill has been referred to the Senate Committee on Labor and Public Welfare, which has cognizance over the National Science Foundation as well as educational activities. The companion bill in the House was referred to the Committee on Education and Labor, which has cognizance over educational matters but not over the activities of the National Science Foundation. Legislation in the House concerning a science information service can, therefore, more conveniently be embodied in separate legislation.

The Senate version of the Hill-Elliott bill authorizes the National Science Foundation to provide or arrange for the

provision of indexing, abstracting, translating, and other services leading to the more effective dissemination of scientific information, and also authorizes the Foundation to undertake programs to develop new or improved methods, including mechanized systems, for making scientific information available. No budget is included, but the bill authorizes the appropriation each year of such sums as may be necessary to carry out these provisions.

Research and information. The Administration bill authorizes the payment of up to $50,000 a year, on a matching basis, to assist any state to improve the adequacy and reliability of its educational statistics. This money is available only for new or expanded services.

The provisions of the Hill-Elliott bill are quite different: the Commissioner of Education is authorized to conduct, assist, and foster reseach on the development and use of television, radio, motion pictures, and related media of communication which may prove of value in education. In the next six years, $55 million would be provided for these purposes. Contracts may be written with educational or other institutions; motion pictures, film strips, recordings, and so on, may be purchased and adapted; and other materials may be obtained for these purposes.

Money and time. The Administration bill would, if enacted, last for four years. At the end of that time its authorization would expire, except for continuing to completion the scholarships and fellowships already granted. It is impossible to state precisely the cost, because dollar figures have not been established for all of the proposed programs. The cost would, however, increase slightly during the four years, because the total number of scholarship and fellowship stipends would increase. In round numbers, approximately $1 billion of Federal money would be called for over the four-year period.

The Hill-Elliott bill would extend for six years, but some of its provisions and authorizations would continue indefinitely. Partly because proposed expenditures in any one year are larger, and partly because the period of time covered is six rather than four years, the total amount of Federal money called for by the Hill-Elliott bill is approximately twice as great as the $1 billion of the Administration bill.

DAEL WOLFLE

AAAS

Control of Space Research

The Council of the Federation of American Scientists, an organization of some 2000 scientists and engineers, released a statement on 5 February that urges that "the most serious consideration be given by Congress and the Administration to placing further U.S. research and development in the field of outer space under civilian control," and that, further, "all outer space research by scientists of all nations be carried out under the aegis of a single international agency under the United Nations." The FAS statement also endorses legislation introduced in the Senate on 23 January by Senator Clinton P. Anderson (D., N.M.) "to achieve the development and control of outer space for peaceful purposes by the United States and all friendly nations working cooperatively. . . ."

Hearings on the proposal (S. 3117) opened on 6 February before the new Subcommittee on Outer Space Propulsion of the Joint Atomic Energy Committee. Anderson, who heads the subcommittee, would place United States space research under the Atomic Energy Commission, authorize a new national laboratory for space research, and urge establishment of an international space research laboratory [*Science* **126**, 331 (14 Feb. 1958)].

Other recent actions related to the administration of space research are as follows.

Senate space advisory group. On 6 February the Senate created a 13-member committee to explore the problems of outer space and recommend whether or not control of future programs should be under civilian or military auspices. A resolution authorizing the new committee was passed by a 78-to-1 vote just 24 hours after it was introduced by Senate Majority Leader Lyndon B. Johnson (D., Tex.). [Simultaneously, Representative Merwin Coad (D., Ia.) introduced a resolution in the House calling for a 31-member committee in that body to make a study of the problems of astronautics and space travel.] The new space group is made up of representatives of the following Senate committees: Appropriations, Foreign Relations, Armed Services, Interstate and Foreign Commerce, Government Operations, and the Joint Committee on Atomic Energy. All Senate bills dealing with astronautics and space exploration, now scattered among these committees, will go to the new committee.

Advanced Research Projects Agency. An Advanced Research Projects Agency to handle "the research and development phases of advanced science programs, including satellites and other outer space projects," was proposed by President Eisenhower in a request to Congress on 7 January for emergency funds to speed U.S. missile and defense programs. The House (15 January) approved a $549 million emergency defense bill, including authorization for establishment of ARPA. The Senate Armed Services Committee approved (28 January) the House-passed bill, but eliminated the provision for ARPA, indicating that it should be dealt with in separate legislation.

However, on 7 February Secretary of Defense Neil H. McElroy announced the establishment of ARPA and the appointment of Roy W. Johnson as its head. Johnson, a vice president of the General Electric Company of New York, will resign from General Electric on 1 April, but will spend two or three days a week on his new assignment prior to that date.

William M. Holaday, director of guided missiles in the Department of Defense, previously had been named to take charge of space planning. He and Johnson will decide between themselves when to transfer responsibilities. The Advance Research Projects Agency is the first federal agency created to devise rockets for outer space, antimissile missiles, satellites, and other vehicles for use in space.

NACA. The National Advisory Committee for Aeronautics proposed, in a resolution released 27 January, that it take over leadership of space research in cooperation with existing military and civilian scientific agencies. NACA director Hugh Dryden said the National Science Foundation and the National Academy of Sciences would plan scientific experiments: NACA would "conduct flights for scientific purposes within its capabilities or jointly" and expand its laboratories. NACA would work with ARPA, and eliminate the need for setting up a new agency or department. Said the *Washington Post* editorially (29 January):

"NACA's plan deserves sympathetic consideration. . . . A new civilian agency like the AEC would lack the advantage of established facilities, personnel, working relationships and experience. All-military control would be unwise . . . any hope of a joint Russian-American venture in space . . . would be seriously diminished by making the American role a military one."

Preparedness Committee proposals. In its Interim Report, released 23 January after extensive hearings, the Senate Preparedness Subcommitteee, which is headed by Senator Johnson, made 17 recommendations to improve the U.S. defense and missile organization. Included were the suggestions that (i) this country "provide for a freer exchange of scientific and technical information between the nations of the free world"; and (ii) "accelerate and expand research and development programs, provide funding on a long-term basis, and improve control and administration