note" of 4140 megahertz with the third harmonic of the accelerator frequency, 2856 megahertz. Self-excited breakup invariably seems to occur in the vertical direction, at 90 degrees with the waveguide couplers. It has also been possible to lower the threshold current for beam breakup artificially by injecting a few milliwatts of 4140-megahertz or 4428-megahertz radiofrequency power into an early 10-foot section of the accelerator. Experimental and analytic work is under way, aimed at gaining an understanding of the mechanism of transverse modulation buildup from noise and to test alternative corrective measures.

Detailed Energy Measurements

Both cumulative and incremental energy measurements have been made over two-thirds of the length and over the full length of the machine to verify the relation between energy gain and radiofrequency power input to the accelerator.

For a constant-gradient structure with negligible beam loading, the energy gain V in a length l having a shunt impedance r per unit length is given by

$$V = (1 - e^{-2\tau})^{\frac{1}{2}} (Plr)^{\frac{1}{2}}$$

where P is the radiofrequency peak power input and τ is the net attenuation of the structure, in nepers. In the Stanford 2-mile accelerator, $\tau = 0.57$, $l = 305$ centimeters, and $r = 53$ megohms per meter. Using these values and correcting for the power loss of 0.54 ± 0.1 decibel in the waveguide system between the klystrons and the accelerator, one obtains the energy gain V per klystron, each klystron feeding a power P into four 10-foot accelerator sections, of

$$V = 19.9\ P^{\frac{1}{2}}$$

where V is measured in Mev and P is measured in megawatts.

For the highest energy run to date (16.4 Gev), the sum of the square roots of all the power inputs from the 208 contributing klystrons was 840 $(\text{Mw})^{\frac{1}{2}}$. Thus the measured constant of 19.5 is in reasonable agreement with the theoretical value of 19.9 given in the above equation.

Further Plans

Accelerator test runs will continue for about 3 months while construction of the beam switchyard and the experimental areas is progressing. After survey experiments on secondary beam production have been made, a scheduled program in elementary particle physics will begin, by late fall 1966.

References and Notes

1. See, for example, R. Borghi, A. Eldredge, G. Loew, R. Neal, "Design and Fabrication of the Accelerating Structure for the Stanford Two-Mile Accelerator," *Stanford Linear Accelerator Center Publ. SLAC-PUB-71* (Jan. 1965) [in "Advances in Microwaves" (Academic Press, New York, in press)]; J. Ballam, G. Loew, R. Neal, in Proceedings of the International Conference on High Energy Accelerators, 5th, Frascati, 1965.
2. See, for example, T. R. Jarvis, G. Saxon, M. C. Crowley-Milling, *Proc. Inst. Elec. Engrs. London Pt. C* **112**, 1795 (1965).
3. The project is being constructed by Stanford University under contract with the U.S. Atomic Energy Commission.

NEWS AND COMMENT

House: Increases for Education, NIH a New Formula for Research Funds

Memorial Day is one of those conveniently spaced national holidays which provide traditional breathers in the congressional schedule. Most legislators go back home, make a ceremonial appearance or two, and tap grass-roots opinion. The congressional mood before and after this Memorial Day long weekend can be described as uneasy.

Anxiety, of course, is a natural state for politicians in an election year. But this year senators up for election and all the congressmen must deal with Vietnam and inflation as live, if unclearly defined, political issues. Inflation seems to favor the outs, but the ins are hoping that full employment will outweigh it.

Vietnam is a principal national concern, but the primaries haven't shown which way it is likely to cut most deeply at the polls. President Johnson's popularity is reportedly down from its record peaks, but in off-year elections, candidates of a President's party seldom lash themselves politically to their national leader.

Present uncertainties and the awareness that it's a long, long way from May to November have dampened the appetite for early adjournment evident —particularly among Democrats—at the end of last year's long session.

Relations between the President and his majority in Congress seem to have frayed slightly, although normal wear and tear could account for it. The President's speech in Chicago 2 weeks ago was interpreted by some legislators as an ultimatum to members of his party to go all the way with LBJ on Vietnam or else, and was resented. And while the administration continues to prevail remarkably often legislatively, Congress has been taking many more liberties in committee this year than last.

Memorial Day marks a legislative watershed in most congresses. Many money bills have moved through the appropriations process, and the rough outline of what Congress is likely to accomplish can be discerned.

Major appropriations bills affecting science and education were sent on their way when the Labor–HEW and Independent Offices appropriations bills passed the House. The Senate has not acted, but radical changes are unlikely, particularly since extension and expansion of existing programs are involved, rather than enactment of new legislation.

The Independent Offices bill included appropriations of $4.95 billion for the National Aeronautics and Space Administration, a reduction of some $62 million in the budget request. More than $4.2 billion of the total was ear-

marked for R & D expenditures, and, of that sum, the entire $3 billion requested for the Apollo program was approved.

The National Science Foundation was voted $479 million, the same sum as for the current year. The administration had requested $525 for NSF. Among the cuts was $19.7 million, the entire amount requested for continuation of Project Mohole (*Science*, 13 May).

The Labor-HEW bill was passed without amendment, giving the two departments and related agencies a total of $10.6 billion ($686.2 of it for the Labor Department). The total represented about $490 more than had been requested by the administration and was appropriated in the face of warnings by President Johnson that increases above his requests would invite tax increases.

The HEW bill did not include a requested $3.9 billion in funds for elementary and secondary schools, grants to developing colleges and for higher-education facilities, public-library grants, and funds for the poverty program. The authorization process on these measures had not been completed in time to be included in the appropriations bill.

On the HEW appropriations, the committee and the House generally followed the administration's budgetary lead, but with some notable and not altogether unexpected exceptions.

In view of the Appropriations Committee's past tight-purse-string record on education legislation, it is something of a surprise that $450 million of the $490 million increase in the bill is accounted for by appropriations to finance four education programs which the administration had asked be reduced or discontinued.

The House voted contributions of nearly $190 million to student loan funds under the National Defense Education Act (NDEA), an increase of almost $156 million over the administration's request. The administration had budgeted for a shift from direct loans to federally guaranteed private loans as one of several money-saving changes in funding of education programs—changes which did not meet with a friendly reception in Congress (*Science*, 4 February).

Representative John E. Fogarty, chairman of the Appropriations Committee's Labor–HEW subcommittee, noted in the debate on the bill that the loan funds and other programs for which increases had been voted were within authorizations which had passed the House by an "overwhelming majority."

An administration effort to reduce federal funds for school districts "impacted" by attendance of children of federal employees was also rejected. Some $416 million, estimated necessary to finance the program on the custom-

Appropriations Committee Comment

The Committee is particularly concerned about the failure of the budget to make proper allowance for the needs of the existing research programs. Recent studies have shown that to maintain the effectiveness and attain the objectives of programs such as those of the National Institutes of Health and the National Science Foundation, the level of support must be increased by about 15 percent per year. This was the conclusion reached in a study undertaken in December 1963 at the request of the Committee on Science and Astronautics by a distinguished panel of the National Academy of Sciences under the chairmanship of Dr. George B. Kistiakowsky. The thoughtful report of this panel was published in March 1965 under the title *Basic Research and National Goals*. Testimony at hearings conducted by the Subcommittee on Science, Research, and Development, chaired by Mr. Daddario, early last year emphasized that such an increment is essential to the maintenance of stable research effort. The subject was further explored during the summer of 1965 by a task force sponsored by the President's Science Advisory Committee which also concerned itself with the specific needs of medical research. The results of this intensive review of the problem have not yet been published but the Committee understands that they fully support the initial recommendation in the report of the National Academy of Sciences Panel. Meanwhile, the principle that 15 percent per year is a reasonable, normal rate of growth for research-support programs has been accepted by the Bureau of the Budget which has applied it in the development of the 1966 and 1967 budget estimates for the National Science Foundation.

The roles of the National Science Foundation and of NIH are complementary in this respect. Together these two agencies administer half of the Federal support for research in academic institutions (in 1965 NSF provided 12 percent of these Federal funds and NIH provided 36 percent). NIH has, in fact, become a major instrument for the support of the academic research community in respect of both fundamental and applied research related to the solution of health problems. This mission is not only clearly set forth in the authorizing legislation for the several categorical Institutes but has been consistently recognized and reaffirmed by the Congress in the process of expanding the NIH programs since 1956. The Committee can see no valid reason for not applying to NIH research-support programs the same minimal growth-factor that has been accepted by the executive branch for NSF.

As the Committee pointed out in its report last year, the need for an annual increment of 15 percent is due to the operation of three factors that affect the cost of conducting research in roughly equal proportion.

Price and wage increases affect the cost of doing business in a research institution just as much as in any other enterprise. The cost of salary increases for professional and supporting technical personnel is a particularly significant factor in biomedical research institutions because a high proportion of their staff has embarked on a science career during the past ten years. A large number of the investigators supported by NIH both in Bethesda and at universities throughout the country are still in the early stages of their careers during which growing scientific competence, professional responsibility, and family requirements must be recognized by fairly regular salary

ary scale, was approved. This was $232.8 million more than requested and $28 million more than was appropriated last year.

The committee recommended, and the House approved, funds totaling $290 million for vocational education programs, some $39 million more than had been requested.

One sizable cut recommended by the administration and sustained by the House, however, was in the program which provides for acquisition of equipment and instruments and for minor remodeling of classrooms under Title III of the NDEA. Funds were reduced from this year's level of $88.2 million to $63.2 for fiscal 1967. When NDEA was passed in 1958, the program provided funds for equipment and remodeling to improve instruction in science and modern foreign languages. It was later extended to include English, reading, and social studies. The program has been a popular one among public school educators, and an attempt to restore funds will be made in the Senate.

The House did put back into the bill nearly $12 million in aid to land-grant institutions. The annual grant had been struck out by the administration in an economy move. The sum is a relatively small one by federal budget standards, but its removal struck a nerve in the body politic of public higher education, and the response was quick and effective.

In the broader context of education politics, the brush over loan and land-grant funds marks the first time in several years that organized higher education has been seriously at odds with the Executive. That working relationship seems to have been ruffled rather than fractured during the past session, and while, on the higher education side, educators understand that the administration is looking hard for ways to economize, they seem to be especially aggrieved at not being consulted on cuts that affected them.

Perhaps a more serious subject of concern now is the problem of financing construction of college housing and academic facilities. The universities and colleges feel that pressures on them for expansion caused by growth in the college-age population are being increased by federal programs, including the new GI Bill, and that the federal government is shirking its responsibility to assist in expanding facilities for both undergraduate and graduate students. The administration understandably wants to hold down construction activity in the interests of keeping down the budget and restraining inflation, but the issue of federal aid for facilities and housing is likely to become the sorest point in federal-university relations; it will be discussed in this space later in the session.

In providing health funds the House has followed the pattern of previous

on Rates of Growth in Research

increases. It is estimated that costs for wages, salaries, equipment, supplies and other items paid from NIH research grant funds have increased a minimum of 5 percent per year since 1960 due to price and wage factors alone.

Improvements in research methods, the constant refinement of the work being done and the increased complexity and precision of the measurements to be made is another major factor in raising the cost of biomedical research. The tools necessary for effective research today are much more complicated and expensive than they were even a relatively few years ago. Electronic devices, which are proving increasingly useful to medical research, become more costly as greater accuracy is demanded from them; the application of computers to research problems greatly enhances the productivity of scientists in many types of research but it also introduces a new and very substantial increase in cost; the general use of primates and germ-free animals has opened up whole new frontiers in medical research but they are a very expensive replacement for the traditional mice, rats and guinea pigs. The studies cited above indicate that the introduction of new research devices and techniques raises the average cost of research projects at an annual rate of at least 5 percent in constant dollars.

The principal purposes of the training programs supported in past years have been (1) to expand the research base and to create a greater national potential for biomedical research and (2) to provide well-qualified scientists for expanding and new medical schools—thirteen new medical schools have already received provisional accreditation and a total of 25 new schools are expected to be in operation by 1975. This investment in research training will be wasted unless funds are now made available to support the work of at least the most highly qualified among the scientists who have been trained. To bring a minimum number of young scientists into research requires an annual increment of no less than 5 percent in the level of support available. These new scientists are needed to meet the manpower needs of *existing* research programs, for successors to present investigators, and for staff for the new medical schools. Present trends in biomedical research make it increasingly necessary to attract physical scientists, mathematicians and engineers into the field and to provide for collaboration by practicing physicians in clinical studies (such as the relationship of drugs to coronary disease) which must be conducted by many different investigators adhering to the same rigid research protocols.

None of the three components of the 15 percent annual increase in the cost of research-support includes the requirements for wholly new programs nor do they provide for a major expansion of current levels of effort.

The Committee believes that the maintenance of a stable medical research effort is clearly in the national interest and that this can only be achieved by providing at least a minimum annual increase in the funds for research-support programs to allow for the widening capability, the growing complexity and the rising costs of research. The Committee feels strongly that this general principle must be applied to the vitally important research programs of the National Institutes of Health.

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years by following the recommendations of the highly influential Fogarty and his subcommittee and topping administration requests substantially. The House voted $2.4 billion for the Public Health Service, nearly $100 million more than was requested.

As usual, the National Institutes of Health received a large share of the increase—some $74 million, which brought the NIH budget for fiscal 1967 to a record level of almost $1.4 billion. Some $30 million of the increase would go to bolster NIH research-grant funds. The committee also acted to relieve the pinch on construction funds for health research facilities. In the committee report on the bill the cutback in construction funds to $15 million was termed "completely unrealistic," and a recommendation for appropriations of $50 million was accepted by the House.

In its report, signed by Fogarty, the committee took the administration to task on research policy, and in the process may have made some important policy itself. The report says, "Not only does the budget make no allowance for initiating or accelerating research where there is both a clear national need and a reasonable promise of success, but a close examination reveals that in the critical items for grant support of research it does not even make adequate provision for sustaining the momentum of already existing programs."

In what very well may be a landmark statement the committee accepts the legitimacy of a 15-percent-a-year upward creep in the cost of research and, interestingly for a congressional document, cites a National Academy of Sciences document as authority for what might be called the Fogarty formula (see pages 1356 and 1357).

In the debate on the appropriations bill on 4 May, Fogarty also made a statement which should warm the hearts of university finance officers. He said that HEW has misinterpreted Bureau of the Budget regulations on cost sharing on grant-supported research projects. Last year Fogarty was instrumental in changing the requirement that institutions administering federal grants be paid 20 percent of direct costs as indirect costs for the proviso that the federal grant may not equal the full cost of the project.

The object was not only to banish payment of a specific percentage on all projects, no matter how varied, but also to "avoid having federal agencies become involved in elaborate and expensive accounting and auditing procedures or in endless arguments about what is and is not admissible as an allowable cost." The same provisions were written into grants awarded by the Department of Defense and Independent Offices agencies, and the Bureau of the Budget, after a long gestation period, issued regulations to cover the new policy.

Now, said Fogarty, "HEW seems to think to comply . . . it must require detailed statements of planned expenditures and exercise control over the funds which institutions contribute to grant-supported research projects."

"It was certainly not," said Fogarty, "the committee's intent to create an accountants' paradise that the HEW regulations will bring into being."

Finishing up his red-tape cutting statement of congressional intent Fogarty said, "The important considerations for the selection of a research project for federal support should continue to be the quality of the research to be performed and its relevance to agency programs, not arbitrary cost-sharing requirements."

For education and health research it seems likely to be a better year than many expected. In the realm of science policy there are encouraging developments for those who can afford to say it's not the money but the principle of the thing.—JOHN WALSH

Sea-Grant Colleges: Idea Gains Adherents

Some excellent germinal ideas have been sown on Capitol Hill only to languish or die for want of the painstaking cultivation required for their growth into government programs. Supporters of the "sea-grant college" concept, however, scarcely could have hoped for it to receive greater attention than it has been getting. This idea is simply that selected institutions would receive federal grants and contracts to enable them to foster practical advances in oceanography somewhat in the manner that the land-grant colleges, by education, research, and extension work, have encouraged advances in agriculture. Although it is too early to predict congressional endorsement of the sea-grant college idea, the interest and support it has aroused in academic, industry, and government circles seems to augur well for its future.

A special Sea Grant Colleges subcommittee, headed by Senator Claiborne Pell, Rhode Island Democrat, is said to have virtually completed its work on the sea-grant bill. However, no more is expected at this session than adoption of the measure by the subcommittee, the parent Labor and Public Welfare Committee, and possibly by the Senate itself. Companion measures to the sea-grant college bill introduced in the Senate by Senator Pell last August have been offered by several members of the House of Representatives, but there is little prospect of House action before the next Congress, at the earliest. The Senate action, though it would not carry over to next year, would be an earnest of congressional interest.

The interest of the academic community already is manifest. Last October 224 persons attended a 2-day conference, at Newport, Rhode Island, on the sea-grant college concept. Most of those attending were from universities or from oceanographic institutions such as Scripps and Woods Hole, although a number of representatives of companies interested in seafood production or marine engineering also were present. Among the academicians at Newport was Athelstan F. Spilhaus, dean of the University of Minnesota's institute of technology, who, in a speech in September 1963 before the