

THE OFFICE OF NAVAL RESEARCH

It has pioneered so fruitfully in the support of basic science that it stands as a model for the planned National Science Foundation

by John E. Pfeiffer

BUILDING T-3, a gray unit in Navy Row on Constitution Avenue in Washington, is one of those "temporary" wartime structures that will probably be in use for another generation or so. It houses a young project that will last a good deal longer. T-3 is the headquarters of the Office of Naval Research, which is primarily military but also represents the first peacetime ven-

ture by the U. S. Government into the large-scale support of basic work in science. As such, it will undoubtedly serve in some respects as a model for the prospective National Science Foundation.

ONR today is the principal supporter of fundamental research by U. S. scientists. Entirely aside from its own military research, in which it employs more than 1,000 scientists at three naval labora-

tories and six branch offices, ONR is sponsoring a huge university program. Its 1,131 projects with workers at more than 200 institutions account for nearly 40 per cent of the nation's total expenditure in pure science. These contracts aggregate \$43 million—more than the entire national expenditure on basic research before the war. Of these funds, \$20 million comes from ONR itself, \$9



ONR'S DIRECTORS meet in weekly Tuesday morning session to consider strategy and projects in its huge pro-

gram of research. At the head of table is the Office's Deputy and Assistant Chief, Captain Calvin M. Bolster.

million is distributed by ONR for other Federal agencies (principally the Atomic Energy Commission, with which it has a cooperative program), and approximately \$14 million is contributed by universities. All of this money is spent in projects chosen and supervised by ONR. Thus a very substantial proportion of U. S. scientists in a wide variety of fields, from astronomy to genetics, are working for the Navy.

The Navy has managed to keep them surprisingly well contented. When ONR started operations three years ago, scientists viewed the tempting contracts it proffered with deep suspicion. They expected that accepting the Navy's money would involve them in stifling red tape, endless discussions with officers lacking in understanding of science, and endless military demands. It turned out otherwise. Many a scientist who vowed at the end of the war that he would never again work for the Government is now working happily for ONR. The Office is so well regarded by the scientific community that it receives four times as many applications for projects as it can finance.

The ONR set-up is far from Utopian, but those who are concerned with organizing the proposed National Science Foundation are examining its methods of operation as an object lesson in Government support of science with a minimum of bureaucracy. The Foundation probably will be considerably closer in operation to ONR than to the wartime Office of Scientific Research and Development, which, though a civilian agency, was concerned only with applied and military research.

MUCH of ONR's success is attributed to its sound basic organization. The Office is run by two naval officers: Rear Admiral Thorvald A. Solberg, Chief of Naval Research, and Captain Calvin M. Bolster, Assistant Chief. But they share control and policy-making with a civilian, Alan T. Waterman, a former Yale University physicist who was a leading official in OSRD during the war and is now chief scientist of ONR. In the selection of university projects to be supported, this triumvirate is assisted by an over-all naval research advisory committee and by 12 advisory panels of scientists, consisting of about 125 leaders in U. S. science. ONR itself has a headquarters staff of scientists who keep in close and sympathetic touch with the university projects.

A second reason for the program's success is that ONR has made good its promise to grant the contracting scientists a maximum of freedom. The Office has operated on the sound assumption that the laboratory worker in basic science hates administrative detail, wants complete freedom of action and publication, and generally is utterly unconcerned about the application of his find-

ings (although ONR officers have observed that he is as gratified as anyone else when others put his work to use).

When a scientist submits a project for ONR support, he is given no blanks to fill out but is asked only to describe his project clearly, list the expenses and needed equipment, and supply other necessary details. After the contract is signed, he is spared any fiscal paper work. The contract is made with his university, and the university administrative office handles the bookkeeping. The scientist is expected to make a progress report every three months, and a final report on completion of his work. Although he is encouraged to publish his work in scientific journals, he is not pressed to break into print at periodic intervals—a convention which has been a long-standing grievance of scientists

working under grants from private foundations.

Like any agency spending the taxpayers' money, ONR has not found it easy to get over the habit of demanding an accounting for every penny and every minute. The armed forces, accustomed to buying chiefly "hardware" to be delivered in definite quantities at definite times and places, at first had a tendency to regard the findings and ideas of research in the same way. They sometimes went to the extreme of insisting on technical reports of a predetermined number of double-spaced, typewritten pages. While ONR has never required its scientist-contractors to punch time clocks (as some laboratories did during the war), it made some attempts to obtain weekly reports of time worked. It was cured of this fault early, notably by a Northwest-

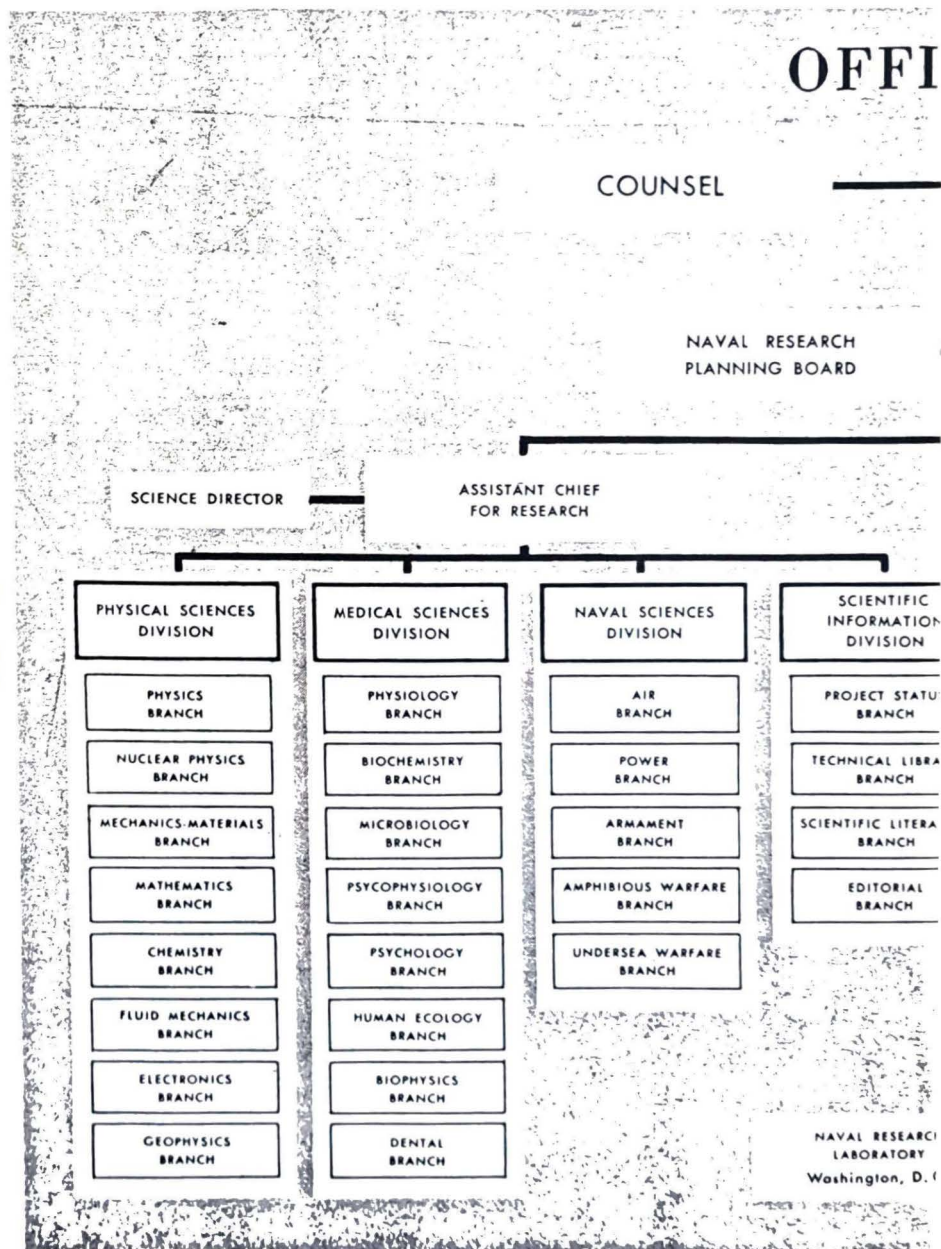


TABLE OF ORGANIZATION shows the scope of ONR's operations. Much scientific work is carried on by men who are employed full-time by ONR.

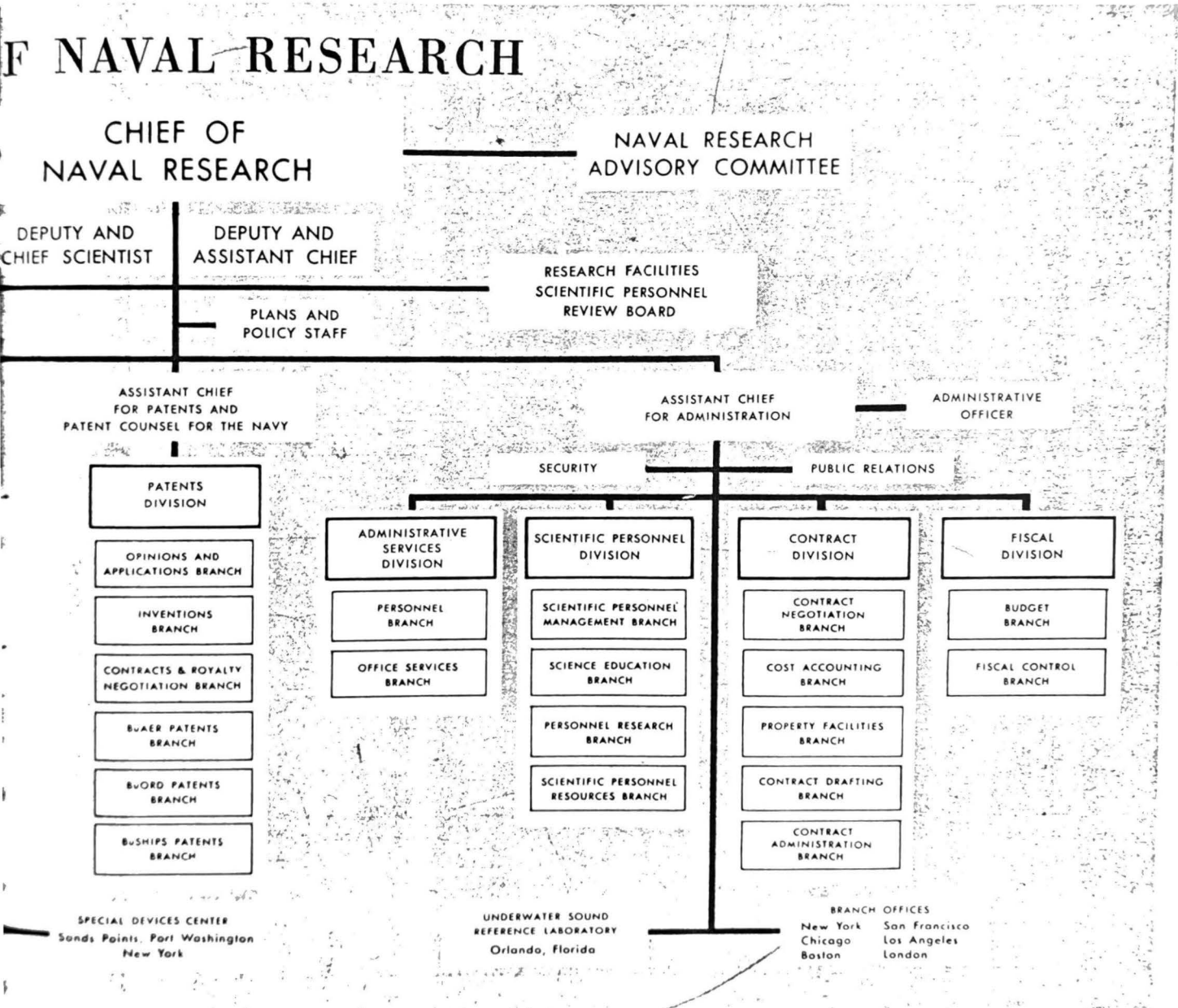
ern University psychologist who was conducting experiments in intelligence testing, and who in mid-contract was requested by a Navy representative to keep track of the time spent on the project by the graduate students helping him. The psychologist complied, and a few weeks later crisply informed ONR headquarters that his assistants, now spending exactly the time they were required to, were working 50 per cent less time than they had previously worked at the same pay. ONR now requires only a monthly report, filled out by an administrative clerk and signed by the project supervisor.

MOST surprising of all has been ONR's ardent and unflagging fidelity to the principle of supporting research of the most fundamental nature—

a principle which was laid down more than three years ago by Vice Admiral Harold G. Bowen, who fathered ONR and became its first chief. ONR is financing at least half a dozen studies in low-temperature physics, an inquiry which before the war was a monopoly of European scientists. It is supporting a Princeton University study of "The Mathematical Structure of American-Type Economics." Its projects include investigations of cosmic rays, meteors, white dwarf stars, viruses, the structure of protein, the biochemistry of muscle and nerve. It is partially financing the construction of 15 cyclotrons, synchrotrons and other accelerators. It has even disregarded service rivalries and assisted entomologist Theodore Schneirla's interesting studies of the army ant.

Many of its projects, of course, are

likely to lead to more immediate naval applications. One study with fascinating possibilities is a psychological analysis of 18 Navy captains who distinguished themselves in combat during the war, to the end of determining what qualities make an outstanding military leader. ONR is assisting in the construction of a high-speed electronic calculating machine that is expected to multiply 40,000 10-digit numbers per second. At Princeton it is supporting a study in statistics designed to yield methods for drawing conclusions from intensive examination of very small samples, e.g., as few as five or ten observations. A typical application of such a technique would be in the investigation of methods for diagnosing cancer, where the number of patients available for study of a particular chemical clue may be very small.



Of principal interest, however, is ONR's policy of support of basic research, which has done much to bridge

the period between the war's end and the anticipated establishment of a National Science Foundation.

Such work is under way at Memorial Hospital in New York City. In a similar project, at the University of Pennsylvania, the role of economic and occupational factors in the speed of the disease process in tuberculosis is being studied.

What does the Navy hope to get out of all this? Admiral Solberg, ONR's chief, insists that the advancement of naval warfare rests ultimately upon the findings of up to the minute basic research. A practical man, Solberg was formerly head of the Naval Boiler Laboratory in Philadelphia and an engine-room officer at sea; he also had charge of the assessment of damage to the warships in the Bikini atomic bomb tests. The basic science projects supported by ONR, he explains, all come under the head of what the Navy calls "supporting" research, which means that they are chosen to fill needs for knowledge considered essential to national security in general and to naval interests in particular. They are selected as far as possible on the basis of their bearing on problems of specific concern to the Chief of Naval Operations and the various bureaus of the Navy. When a report is rendered to ONR on the results of a project, significant findings are passed along to naval laboratories and other interested service agencies, where they may be put to use in practical design problems. Findings in physical science are reported to naval engineers, biological data to naval physicians and surgeons. The results of psychological and sociological studies are applied to problems of human engineering, training, personnel selection and leadership.

To achieve a more accurate selection of pertinent projects, ONR is now developing a section devoted to "program research." This section is analyzing Navy objectives with a view to uncovering gaps, weak spots or critical areas where research is needed. For example, naval tacticians may pose such a problem as this: A large task force of many carriers and aircraft is attacking a small, well-defended military zone under conditions of zero-zero visibility. What new weapons and devices, and hence what basic research, would be needed to increase significantly the chances of destroying the target? ONR has already drafted several research programs which are based on such practical problems as these.

For obvious reasons, ONR, while willing to disclose many of the individual projects for which it has contracted, will not permit publication of the entire program.

AS far as the scientists are concerned, ONR's system imposes no hampering directives. The research program is "directed" only in the sense that ONR selects projects which it considers to be pertinent to its own plans. For the most

part the projects are proposed by the scientists themselves. Their work follows the lines of their own interests and inclinations; if their basic studies are deemed of value to the Navy they obtain support which often would be unavailable from any other source. Few of the scientists who work under ONR contracts express any particular concern about the fact that their work may advance military technology. They consider that the source of funds is relatively incidental. They are doing exactly what they want to do under conditions of complete scientific freedom, and the basic contributions they are making to scientific knowledge have their own value, not restricted to possible uses by the Navy.

Obviously the scope of ONR's support of fundamental work depends on the breadth of its interpretation of what may be useful to the Navy. So far this interpretation has been liberal, as is indicated by the sample projects already mentioned. Yet there are limitations—limitations that not only underline the need for the speedy establishment of a National Science Foundation but suggest some lessons that such an agency might be able to learn from ONR's pioneering experience.

One lesson is that the achievement of a balanced program of research cannot safely be left to the unregulated processes of supply and demand. Of ONR's basic-science budget, more than 75 per cent has been spent in the physical sciences and only 15 per cent in the biological and medical sciences. (The remaining 10 per cent or so has been allotted to naval sciences.) The value of research in nuclear physics is more obvious to the Navy (and to civilian agencies, one may note) than is the value of research in the life sciences. The Navy also argues that medical research is being supported by many other agencies. In any case the one to five ratio of biological to physical science that has developed in the ONR program is far below the one to two ratio suggested by Vannevar Bush of OSRD in his proposal for a science foundation to President Truman. Biologists also point out that the U.S.S.R., which cannot be accused of diverting funds to impractical research, has undertaken to expand its biological research program rapidly since the end of the war.

Another reason for ONR's relatively small support of biology may be the failure of the biologists to press their case in an organized way. Engineers, chemists and physicists have promoted their professional interests through active, long-established national organizations. The biologists, realizing their handicap, a year ago formed the American Institute of Biological Sciences, but the organization has shown little sign of life. Its inactivity may account for the fact that

ONR's 13-man advisory committee has only two biologists.

Perhaps the most serious weakness in the ONR system of support has been the short duration of its contracts. They average just under a year and a half—far too short a period to give scientists the degree of security they need in basic research, where results do not come overnight. Moreover, under the ONR plan a scientist may run out of funds just when the work is becoming most interesting to him. His mission for the Navy presumably is accomplished when he has delivered certain desired information. But the research may have opened an unexpected new line of inquiry which intrigues him even more than the original project. Because the Navy cannot be expected to continue to support the pursuit of pure knowledge beyond its own limited aims, the scientist must either give up the inquiry or start a new hunt for funds from another source.

All of these problems are now being intensified by a shrinkage in ONR funds. Its allowance depends not only on the size of the nation's military budget but also on the competitive demands of other military agencies upon that budget. President Truman's budget for the coming year allows \$530 million for military research and development. This is divided up among the Army, Navy and Air Force; and of the Navy's allotment, the lion's share then goes for "development," meaning engineering and test production of devices. What is left goes into basic research. Because of other demands on ONR, some of next year's contracts may be cut by 15 to 20 per cent. Most of the current contracts range from \$12,000 to \$40,000. In an average contract of \$25,000, some \$14,300 goes for the salaries of research workers, \$5,000 for equipment, travel, and so on, and the remaining \$5,700 to the university for overhead expenses.

There are other indications that ONR is preparing to cut back the scope of its support of basic science. It is planning to expand its naval sciences division, which finances studies connected with the development of rockets, jet propulsion and other military projects. Within two years this division will take a larger percentage of ONR's budget, thereby reducing the share for basic research.

For these reasons among others, scientists are now pressing concertedly for immediate enactment of the National Science Foundation Bill. ONR has tided them over what would otherwise have been a lean postwar period. Without an ONR, scientific work in the universities at this moment would be very seriously curtailed.

Many scientists regret that the scientific community at the end of the war did not achieve the realism and purpose exhibited by the naval officers who founded ONR. The organizers of ONR under-

stood political realities and got what they wanted. While scientists debated *whether* the Government should support basic research, ONR's founders, sensing that events had already settled that question, addressed themselves to the question of *how*. If scientists had adopted the same approach, the National Science Foundation might well be in existence. In any case, scientists are grateful to ONR for demonstrating the inevitability of such an organization.

The National Science Foundation is now regarded as "imminent." Its chances are enhanced by the proposed establishment of a Cabinet post and executive department for social welfare, under which a science foundation would logically find its place. Scientists who are interested in the foundation, considering the major issue settled, are already working on the problem of getting an adequate appropriation. The President's budget proposes \$15 million for the foundation's first year. Many scientists have written letters to the presidents of their universities urging an appeal to the President to raise the initial appropriation to \$50 million as recommended in the famous Steelman Report. A memorandum accompanying these letters points out that advisory panels of ONR have approved basic-research projects totaling some \$25 million which cannot be undertaken because of lack of funds.

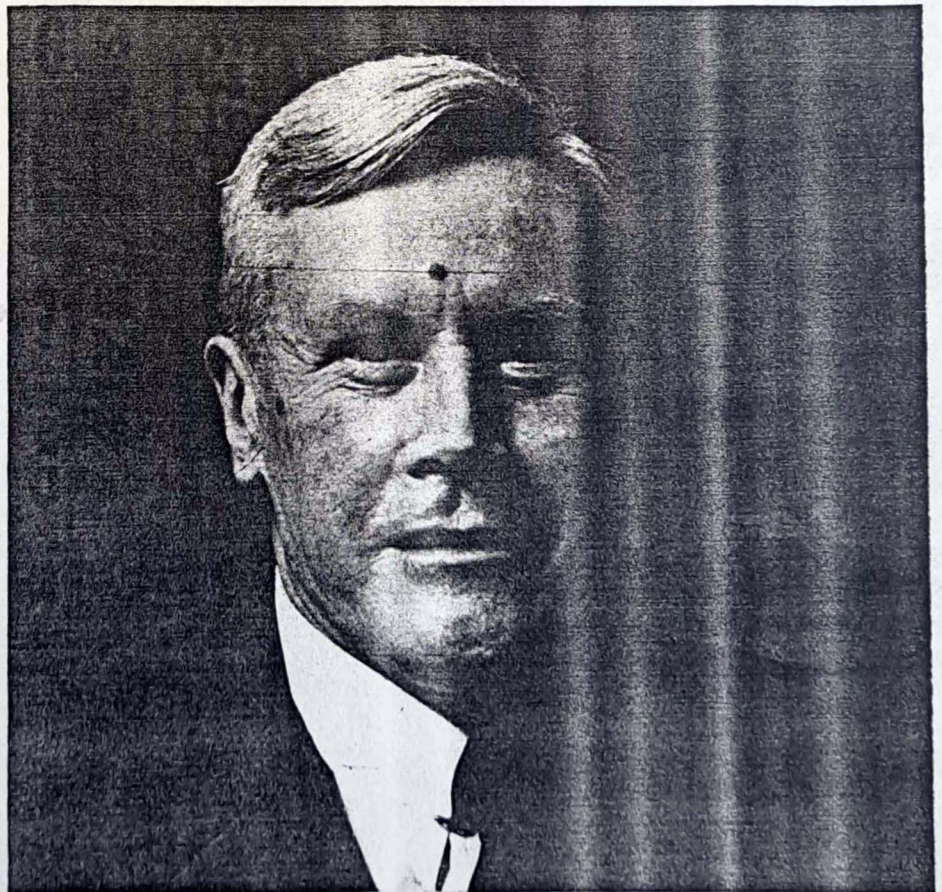
MEANWHILE ONR, whether or not a science foundation comes into being, has no intention of going out of business. Contrary to the impression of many scientists, it does not consider its support of basic science a stopgap enterprise. To be sure, the Navy officially supports the proposal for a science foundation, and it might perhaps willingly transfer up to 25 per cent of its projects to such a foundation. But Admiral Solberg and others made it clear that, foundation or no foundation, ONR intends to continue to sign contracts with scientists for many fundamental studies—a policy which it considers absolutely essential to the continued technological improvement of the Fleet.

ONR takes a justifiable pride in its pioneering accomplishment. It likes to quote a remark made two years ago by Admiral Bowen, which contains more than a grain of truth: "You could move the Office to another building, put a new sign over the door reading 'National Science Foundation,' and you would have considerably more than the nucleus of such an agency."

John E. Pfeiffer was the author of Enzymes, which appeared in the December issue of this magazine.



REAR ADMIRAL THORVALD A. SOLBERG is the present Chief of Naval Research. He was head of the Naval Boiler Laboratory at Philadelphia.



ALAN T. WATERMAN is Chief Scientist of the ONR. Formerly a Yale University physicist, he was an official in the OSRD during the war.

1953

DEPARTMENT OF THE NAVY ¹

The Pentagon

Liberty 5-6700. Information

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Marine Corps Aide	LT. COL. J. V. KELSEY, USMC.
Administrative Aide	CAPT. H. V. BIRD, USN.
Civilian Aide	T. B. WRIGHT.
Under Secretary of the Navy	CHARLES S. THOMAS.
Naval Aide	CAPT. J. W. AILES, III, USN.
Marine Corps Aide	LT. COL. J. C. SHORT, USMC.
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Aide and Special Assistant	COMDR. J. B. KACKLEY (SC), USN.
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Special Assistant	C. H. MAYER.
Assistant Secretary of the Navy for Air	JOHN F. FLOBERG.
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Special Assistant	B. B. BRAY, Jr.
Special Assistant	C. R. SCHEDLER.
Administrative Assistant to the Secretary of the Navy	JOHN H. DILLON.
Assistant	R. H. DUNNINGTON.
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Assistant Comptroller, Accounting, Audit, and Finance	N. P. CASSIDY.
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Office of Information, Chief	REAR ADM. LEWIS S. PARKS, USN.
Navy Management Staff, Director	(VACANCY).
Office of Naval Material, Chief	VICE ADM. C. W. FOX (SC), USN.
Office of Analysis and Review, Director	(VACANCY).
Office of Naval Petroleum and Oil Shale Reserves, Director	CAPT. R. H. MEADE (CEC), USN.
Assistant to the Director (Liaison)	COMDR. W. M. GUSTAFSON (CEC), USN.
Office of Naval Research, Chief	REAR ADM. C. M. BOLSTER, USN.
Chief of Naval Operations	ADM. W. M. FECHTELER, USN.
Vice Chief of Naval Operations	ADM. D. B. DUNCAN, USN.
Naval Inspector General	REAR ADM. J. CARY JONES, USN.
Deputy Chief of Naval Operations (Personnel)	VICE ADM. JAMES L. HOLLOWAY, Jr., USN.

¹ Organization chart on p. 561.

NAVY¹

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 REAR ADM. LEWIS S. PARKS, USN.
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 REAR ADM. J. CARY JONES, USN.

VICE ADM. JAMES L. HOLLOWAY, JR., USN.

Chief of Naval Operations—Continued	
Deputy Chief of Naval Operations (Administration)-----	REAR ADM. JOHN GINGRICH, USN.
Hydrographer-----	CAPT. J. B. COCHRAN, USN.
Superintendent, Naval Observatory-----	CAPT. F. A. GRAF, USN.
Deputy Chief of Naval Operations (Operations)-----	VICE ADM. M. B. GARDNER, USN.
Deputy Chief of Naval Operations (Logistics)-----	VICE ADM. R. F. GOOD, USN.
Deputy Chief of Naval Operations (Air)-----	VICE ADM. R. A. OFSTIE, USN.
Chief, Bureau of Aeronautics-----	REAR ADM. T. S. COMBS, USN.
Deputy and Assistant Chief-----	REAR ADM. L. HARRISON, USN.
Chief, Bureau of Medicine and Surgery-----	REAR ADM. H. L. PUGH (MC), USN.
Deputy and Assistant Chief-----	REAR ADM. C. J. BROWN (MC), USN.
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Deputy and Assistant Chief-----	REAR ADM. W. S. PARSONS, USN.
Chief, Bureau of Ships-----	REAR ADM. H. N. WALLIN, USN.
Deputy and Assistant Chief-----	REAR ADM. W. D. LEGGETT, JR., USN.
Chief, Bureau of Supplies and Accounts-----	REAR ADM. M. L. ROYAR (SC), USN.
Deputy and Assistant Chief-----	REAR ADM. W. W. HONAKER (SC), USN.
Chief, Bureau of Yards and Docks-----	REAR ADM. J. F. JELLEY (CEC), USN.
Deputy and Assistant Chief-----	CAPT. A. D. HUNTER (CEC), USN.
Judge Advocate General of the Navy-----	REAR ADM. IRA H. NUNN, USN.
Assistant Judge Advocate General-----	CAPT. S. B. D. WOOD, USN.
Commandant of the Marine Corps-----	GEN. L. C. SHEPHERD, JR., USMC.
Assistant Commandant and Chief of Staff of the Marine Corps-----	LT. GEN. G. C. THOMAS, USMC.

CREATION AND AUTHORITY.—The Department of the Navy and the office of the Secretary of the Navy were established by act of Congress approved April 30, 1798 (1 Stat. 553; 5 U. S. C. 411-12). For 9 years prior to that date by provision of act of Congress, approved August 7, 1789 (1 Stat. 49), the conduct of naval affairs was under the Secretary for the Department of War.

The Board of Navy Commissioners (consisting of three members) was created by the act of February 7, 1815.

The act of August 31, 1842 (5 Stat. 579; 5 U. S. C. 429), abolished the Board of Navy Commissioners and established the Bureau of Navy Yards and Docks, Bureau of Construction, Equipment, and Repair, Bureau of Provisions and Clothing, Bureau of Ordnance and Hydrography, and Bureau of Medicine and Surgery.

The act of July 5, 1862 (12 Stat. 510; 5 U. S. C. 429), established the following organizations: Bureau of Yards and Docks, Bureau of Equip-

ment and Recruiting (later changed to Bureau of Equipment and still later abolished), Bureau of Navigation (now Bureau of Naval Personnel), Bureau of Ordnance, Bureau of Construction and Repair, Bureau of Steam Engineering (later changed to Bureau of Engineering, which, with Bureau of Construction and Repair, was abolished on June 20, 1940, when their respective functions were reassigned to the newly established Bureau of Ships), Bureau of Provisions and Clothing (later changed to Bureau of Supplies and Accounts), and Bureau of Medicine and Surgery.

The Office of Chief of Naval Operations was established by the act of March 3, 1915 (38 Stat. 929; 5 U. S. C. 422).

The Bureau of Aeronautics was established by the act of July 12, 1921 (42 Stat. 140; 5 U. S. C. 439).

The present organization and distribution of functions within the Navy's executive organization are derived from statutes, Executive orders,