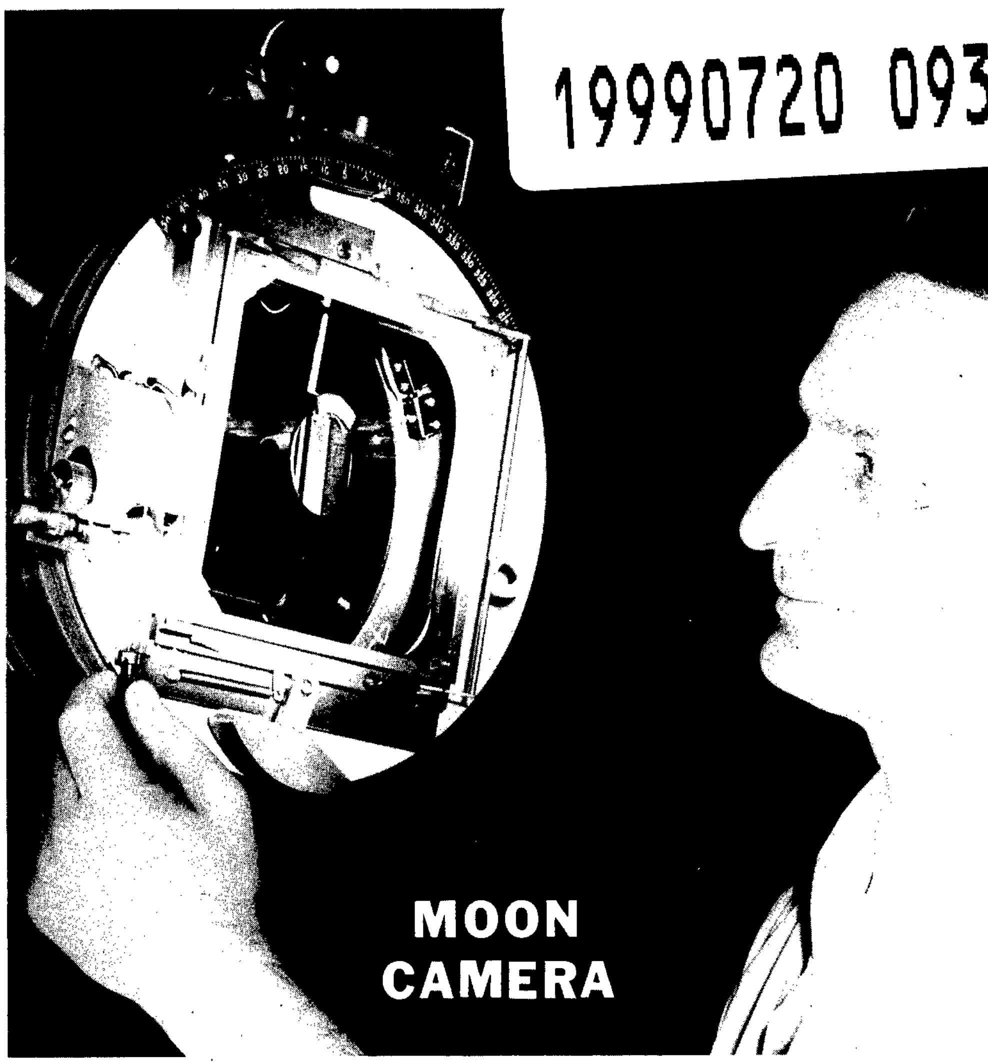
OFFICE OF NAVAL RESEARCH AUGUST 1957

RESEARCH REVIEWS



DEPARTMENT OF THE NAVY
WASHINGTON, D. C.

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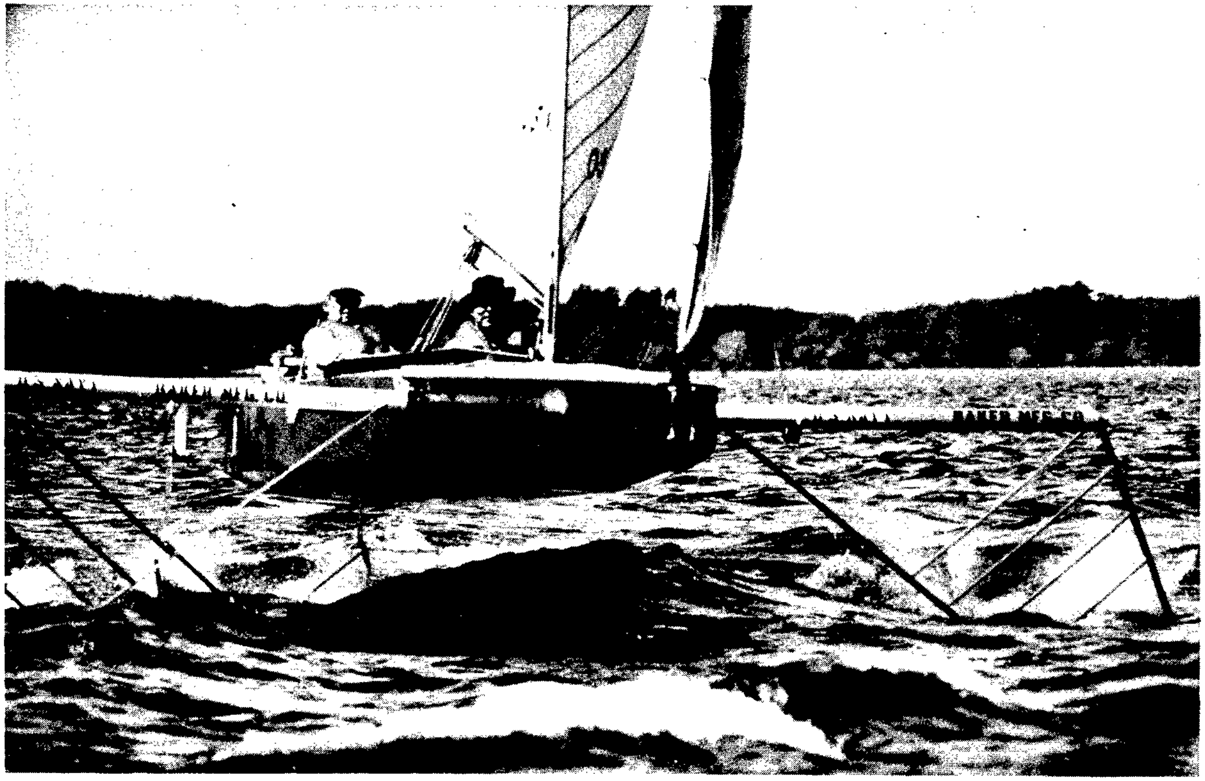
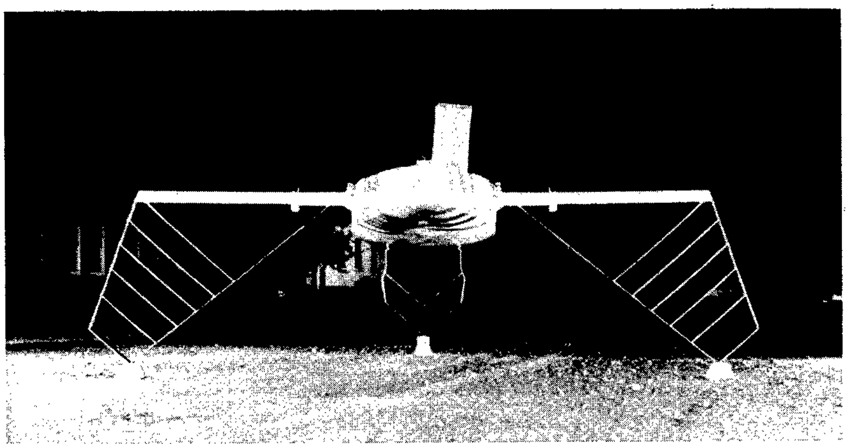


The "Monitor" in flight.



Hydrofoil system of the "Monitor."

The Flying Sailboat

J. G. Baker
President
Baker Manufacturing Company

The combination of the wind as a source of propulsive power and hydrofoils for sustentation promises exciting new horizons for the sailing enthusiast.

Hydrofoils are something like waterskis on a boat, but with the important difference that they run submerged so that lift is produced on both the upper and lower surfaces, just as it is on an airplane wing. This lift causes the hull to rise entirely clear of the water, thus greatly reducing the forward resistance and avoiding the pounding forces experienced by a planing or displacement hull at high speed. The sensation of riding in and operating a hydrofoil sailboat is unique, particularly when climbing free of the water's surface and when accelerating during flight as the result of a change in course or trimming the sheets. The obvious magnitude of the elemental forces that are brought to play with so little noise is equally impressive.

Much of the recent progress in the development of hydrofoil sailboats has been made possible through the interest of the Office of Naval Research in obtaining hydrodynamic data on hydrofoil configurations in a relatively inexpensive way and without the complication of separating out the effects of propellers, struts, and propulsion plants. In this article, however, only those aspects that are of particular interest in the application of hydrofoils to sailboats will be emphasized.

Most experiments with hydrofoils have been carried out with power boats, but sailboat applications have been investigated by A. Locke, R. Gilruth, and W. P. Carl, Jr., and by the Baker Manufacturing Company, which has built two different hydrofoil sailboats, a 16 footer and the 26-foot "Monitor." The latter boat, which was built as a company project and equipped with foils fabricated under a contract with the Office of Naval Research, has sailed at a speed of 30 knots.

Hydrofoils offer more of an advantage to a sailboat than they do to a motorboat. The reason they do is that the propulsion thrust of a sail increases with speed while the maximum obtainable thrust from a given engine decreases with an increase in speed through the water. In a beam wind of a given velocity an increase in sail speed by a factor of four increases the maximum obtainable thrust about 1.5 times. (This holds as long as the sail speed is not over four times the wind speed.) By contrast, an increase in speed of a motorboat by a factor of four with the same engine means a reduction in the maximum obtainable thrust to about one-quarter.

The increase in propulsion thrust of a sail with speed is well demonstrated by iceboats. In a 10-knot breeze, for instance, it may be necessary to push an iceboat to get it started, but once underway it may skim over the frozen surface at 40 knots. It is for this reason that the ratio of potential gain in speed due to reducing forward resistance by the use of hydrofoils is much greater for the sailboat than for the motorboat.

Unfortunately, if the maximum propulsion thrust is obtained, the sail side force—the component of the resultant force on the sail perpendicular to the course—increases by a much larger factor than that by which the forward thrust increases. At high speed the side force and resulting rolling moment under the condition of maximum propulsion thrust become so large that the lateral spacing and area of the hydrofoils needed to counteract them would be too great to be practical.

Fortunately, once a hydrofoil sailboat has attained enough speed to become foil-borne, she no longer needs the maximum thrust of her sail to keep her flying. By using a flat sail, trimmed to spill some of the wind, a skipper can fly his boat without rolling the lee foils under. Even with this reduction the forces on the sail are enormous, because during flying the relative wind reaches gale velocities. With a canvas sail it is difficult to maintain a proper sail shape, and considerable effort is required to trim the sheets. For these reasons a rigid sail appears desirable, if the problem of cost and transportation over land could be overcome.

In addition to supporting the boat, the hydrofoil system of a flying sailboat must, of course, sustain all reactions of the sail not supplied by the weight and the weight distribution of the boat. The ability of the hydrofoil system to counteract the high side force of the sail depends (1) on the projected area of the hydrofoils in a vertical plane parallel to the keel and (2) on the type of hydrofoil configuration.

The rolling moment produced by the side force acting at the center of area of the sail can be balanced partly by shifting weight to windward, but the main reliance must be on the difference in submergence and angle of attack between the windward and leeward hydrofoils. The

The 16-foot flying sailboat.

magnitudes of these differences depend on the lateral spacing and the type of hydrofoil.

The V-foil configurations of the 16-foot flying sailboat (see photograph above) and of the model hydrofoil system (see photograph on page 4) require wider lateral spacing of the hydrofoils for the same rolling moment than does the ladder-foil configuration of the "Monitor." With adequate projected area and lateral spacing of the hydrofoils, the necessary side force and rolling moment reactions can be sustained without difficulty.

The forward thrust acting at the center of area of the sail causes a pitching moment tending to bury the bow, but this is balanced by the greater lift of the forward foils and the distribution of weight aft. A slowly changing thrust can be offset by either a longitudinal weight shift or manual adjustment of the foil-angle settings to vary their lift. However, with a quick change in thrust as occurs with a gust of wind or an alteration in course, the errors in such adjustments are apt to result in either a sharp climb or drive of the boat. In case of a climb the foils lose their lift through ventilation (entry of air along the upper, low pressure surface), and the boat drops onto the surface of the water. In case of a dive the boat plunges into the water, stopping suddenly.

The rate of climb or dive due to variation in pitching moment can be reduced by increasing the fore and aft spacing of the hydrofoils. The amount of pitching-moment variation which can be tolerated increases about as the square of this spacing. Where adequate spacing means too long a boat, automatic regulation of trim under the varying pitching moment is needed.

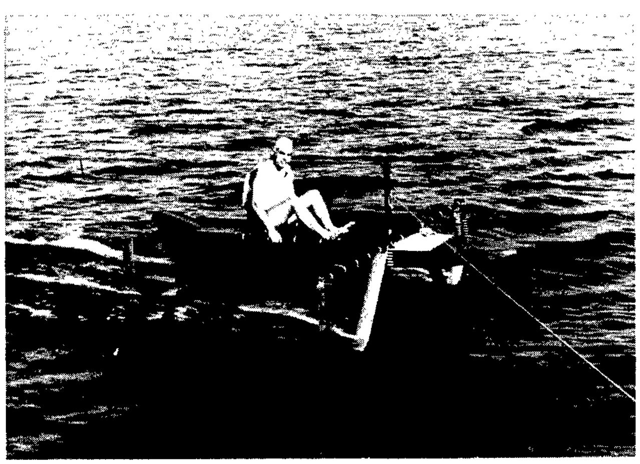
In the case of the "Monitor," automatic trim regulation is accomplished by continuously determining the pitching moment of the sail on the hull with a mechanical computer and using a motion proportional to the pitching moment to vary the angle setting of the rear foil. This produces an opposite pitching moment on the hull. When the thrust increases, some over-compensation is made so that moderate climb is introduced. No power is required to operate the regulator other than that derived from the sail.

In order to steer either the V-foil or the ladder-foil system, the rear foil unit is rotated about an upright axis. A semicircular tiller is attached directly to the foil structure of the 16-foot flying sailboat. The "Monitor" is steered from the cockpit with a wheel mechanically connected through a suitable reduction to the rear foil.

The photograph below shows a model hydrofoil system designed for use on a flying sailboat undergoing a towing test. The side force and rolling moment of the sail are simulated on the rig by attaching the tow line over the deck on a post and by guiding the model with respect to the towing boat in such a way as to make the line of tow coincide with the line of action of the resultant force of a sail if one were used.

The specifications for the 16-foot flying sailboat are as follows:

- Sail area - 115 square feet.
- Length of hull - 16 feet.
- Overall width - 22 feet.
- Approximate maximum elevation above the water of the hull bottom in flight - 2 feet.
- Top speed - About 20 knots.



Tow test of a hydrofoil system for a flying sailboat.

The "Monitor" in flight.

- Wind velocity required to fly - About 13 knots.
- Number in crew - 1.
- Pitching moment partly compensated by fore and aft movement of operator.
- Rolling moment partly compensated by lateral movement of operator.
- No adjustment of the angle setting of the foils with respect to the hull in flight.
- Steering - By rotation of rear hydrofoil unit.

The 16-foot flying sailboat operates well in steady flight on a reach or a beat. It will point about as high as a conventional sailboat—an Inland Lakes Scow, for example. Acceleration or deceleration must be limited in order to avoid either diving or excessive climbing with consequent ventilation and dropping. The boat can be jibed without the hull touching the water. In coming about, the hull does touch down. When stationary the boat has a strong tendency to remain in stays.

The following specifications are for the "Monitor":

- Sail area - 230 square feet.
- Length of hull - 26 feet.
- Overall width - 21 feet.
- Approximate maximum elevation above the water of the hull bottom in flight - 2 feet, 6 inches.
- Top speed - About 30.4 knots.
- Wind velocity required to fly - About 13 knots.
- Number in crew - 2.
- Automatic trim regulation with varying thrust.
- Rolling moment partly compensated by differential adjustment of foil angles.
- All foil incidence angles adjustable in flight.
- Steering - By rotation of the rear foil.

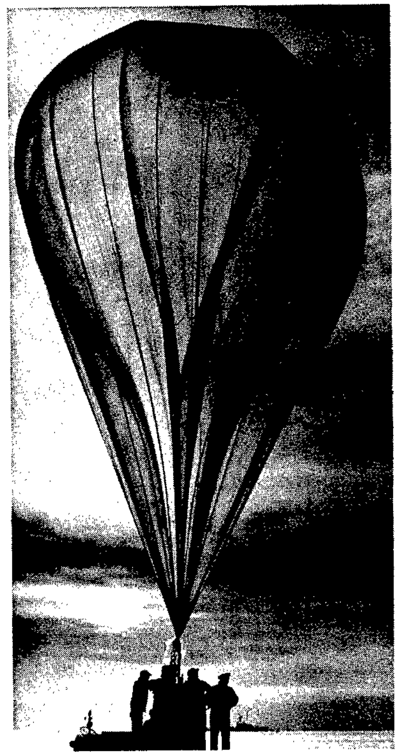
The trim regulation on the "Monitor" eliminates the pitching-moment difficulties associated with acceleration on the 16-foot boat. The "Monitor" does not point as high as the 16-foot boat due partly to compromises for high speed. There is no difficulty in getting out of stays because of the jib. The roll resistance when the hull is in the water needs to be increased.

SPEED COMPARISONS

Type of Boat	Name	Knots	Date	Source of Information
American Cup Boat	Yankee	13.5	1931	Communication from Yachting Publishing Corp., N. Y., N. Y., Sept. 19, 1955.
Clipper Ship	Sovereign of the Seas	17.7	About 1854	"Clipper Ship Days," by John Jennings, published by Random House, N.Y., N.Y., 1952.
Catamaran	—	25.0	1952	"World's Fastest," Life Magazine, Aug. 25, 1952, Vol. 33, Pg. 55.
16-foot Flying Sailboat	—	20.0	Before 1952	Comparison with a motorboat with a known speed-tachometer relationship.
Flying Sailboat	Monitor	26.1	Sept. 1955	Comparison with two different motorboats with known speed-tachometer relationships.
		30.4	1956	Comparison with Univ. of Wisconsin motor lifeboat, which has a known speed-tachometer relationship.

Although the results achieved thus far in flying sailboat development are encouraging, there remains considerable room for improvement in the sail rig, the hydrofoil system, and in the structure. The main need is to lower the wind velocities required for flying in order to increase the opportunities for high speed travel. It is expected that eventually flight will be possible in about a 10-knot wind instead of the 13-knot wind required at present.

Weather Reporting by TRANSOSONDE



Giant Navy weather balloons of the type pictured at right are now being launched at regular intervals from Japan for flights across the Pacific Ocean. The balloons, which fly at an altitude of 30,000 feet, are geared to telemeter time signals and temperature and pressure data in Morse code for a 16-minute interval every 2 hours. By means of this system—called TRANSOSONDE, short for trans-ocean sounding (See Research Reviews, Oct. 1955)—Navy meteorologists obtain weather data that enable them to make sharper and more accurate forecasts for hundreds of thousands of square miles of ocean in which islands do not exist, and from which, therefore, regular weather reports have not previously been made. In the Pacific, especially, such forecasting is vital to efficient surface and air operations.

The balloons and the instruments they carry were developed by the Naval Research Laboratory for the Bureau of Aeronautics.

Change of Command at NTDC

At impressive full-dress military ceremonies held at Sands Point, New York, on June 20, CAPT Edward C. Callahan, USN, relieved CAPT C. H. S. Murphy, USN, as Commanding Officer and Director of the Naval Training Device Center.

CAPT Callahan comes to the Training Device Center from the Bureau of Aeronautics where he has been Assistant Director of the recently established Avionics Division. CAPT Murphy, who has been the Center's Commanding Officer and Director since November 1954, has been ordered to the Naval Air Missile Test Center, Point Mugu, California, where he will serve as Director of Tests.

RADM L. DeFlorez, USNR (Ret.), noted engineer, inventor, naval aviator, and founder of NTDC made the principal address. Other speakers included RADM M. E. Miles, USN, Commandant, Third Naval District; CAPT J. A. Fitzgerald, USN, who represented RADM R. Bennett, Chief of Naval Research; COL K. H. Hunter, USA, Associate Director (Army) at NTDC; and CDR W. G. Normile, Commanding Officer, NTDC Supply Office.

An Improved Method for Measuring Adhesion

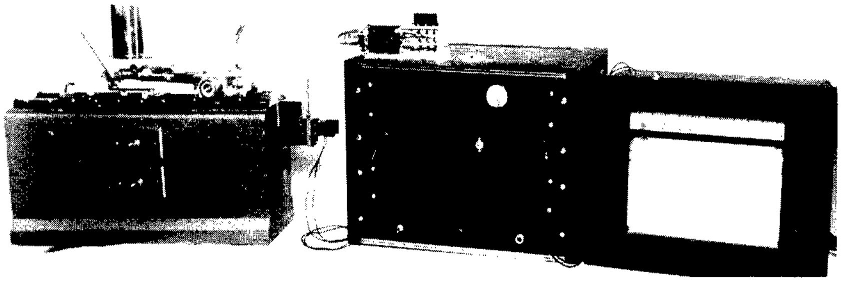
The ever increasing speeds of modern aircraft have developed a need for methods of evaluating the adhesion property of protective coatings for these aircraft. So that potential coatings might be effectively screened in the laboratory, the National Bureau of Standards, under the sponsorship of the Navy Bureau of Aeronautics, recently made a study of available adhesion measuring instruments.

One of the promising instruments investigated was the adherometer. This apparatus measures the force required to strip a coating from a metal surface. To obtain the measurements, a coating sample is mounted on a motor-driven plate that travels under a weighted knife. The variable force encountered as the coating is removed is then reflected on a dial gage. But the process of recording and averaging many dial-gage readings is lengthy and laborious and the results obtained are not always reliable.

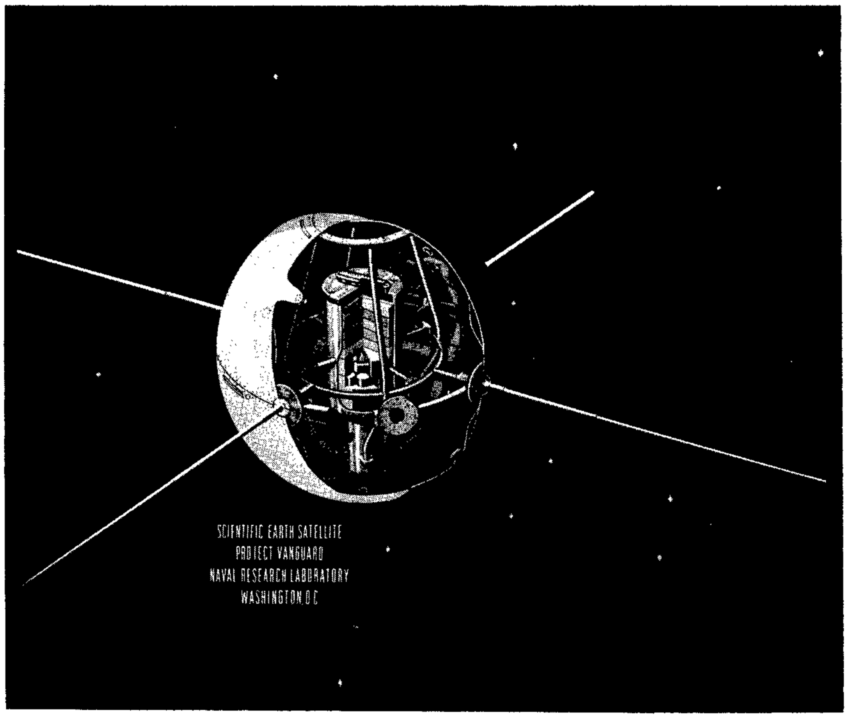
To increase the speed, ease, and precision with which adherometer measurements can be made, NBS developed a device that converts the variable stripping force measured by the adherometer into electric impulses. This device, called the Integrometer, gives a single average value for the stripping force which can be read directly from a standard recorder.

Stripping tests made by the dial-gage method on 11 different coating materials exhibited a coefficient of variation of 4.1 percent. When the Integrometer was used, the coefficient of variation was 2.2 percent. The stripping tests also indicated that measurements made by the dial-gage method became less accurate as the adhesion property of the coating became less uniform, whereas those made by the Integrometer method were not affected by this condition.

In addition to increasing the speed and precision of adherometer measurements, the Integrometer is expected to provide a more reliable experimental basis for the interpretation of adherometer data. It should also be useful in making theoretical studies of adherometer operation and in the correlation of adherometer measurements with other adhesion measurements and with data on service performance.



The Integrometer (center) connected to an adherometer (left) and to an automatic recorder (right).



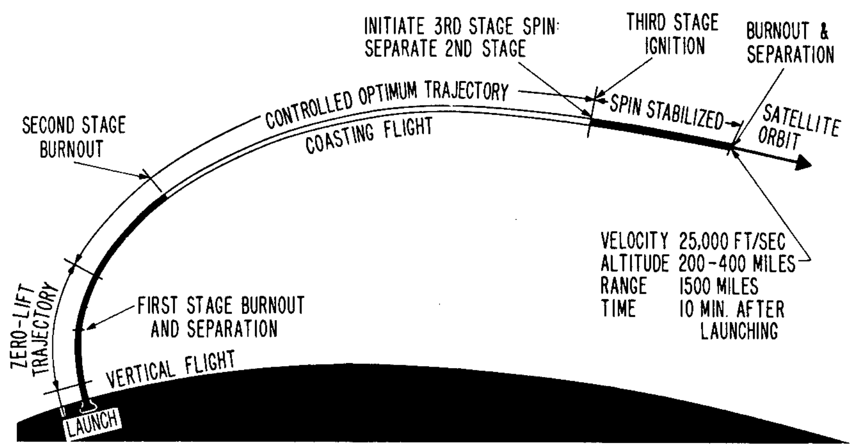
Cutaway view of the scientific earth satellite, showing instrumentation.

The Navy's Support of the IGY

The 1st of July officially marked the beginning of the International Geophysical Year. During the remainder of 1957 and all of 1958, the world's scientists will participate in an unprecedented study of our physical environment. Comprehensive investigations on a world-wide basis will be carried out in the fields of meteorology, latitude and longitude determinations, geomagnetism, gravity measurements, ionospheric physics, aurora and airglow, solar activity, cosmic rays, glaciology, oceanography, seismology, and upper atmosphere studies using rocket and satellite vehicles.

The Navy is vitally interested and actively participating in the IGY. This is indicated, principally, through the work it is doing toward launching an artificial satellite into an orbit around the earth. However, the Navy is also engaged in important work in many other fields. These include the longitude and latitude program, the Antarctica expeditions, the rocket program, the oceanographic program, and the cosmic-ray studies.

A brief description of the Navy's role in these fields is presented pictorially on the following pages.



Flight path of three-stage vehicle that will place satellite in orbit.

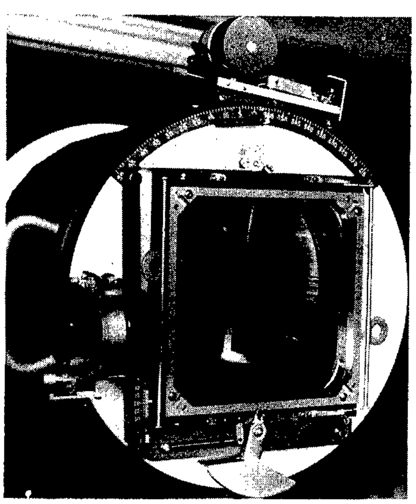
● EARTH SATELLITE PROGRAM

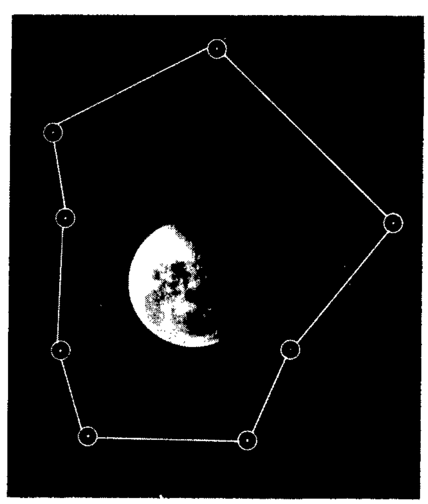
Experiments carried out by means of artificial satellites are expected to help scientists make better determinations of the size and shape of the earth; of upper-atmosphere densities, temperatures, and pressures; and of cosmic rays, solar ultraviolet rays, and X-rays.

● LONGITUDE AND LATITUDE PROGRAM

A special camera developed by the Naval Observatory in Washington, D. C., will be used during the IGY to facilitate the study of such problems as the determination of uniform time, of changes in the speed of rotation of the earth, and of the size and shape of the earth. Called the moon-position camera, it offers a means of determining, photographically, the position of the moon relative to the stars.

Left, moon-position camera. Right, moon and surrounding reference stars (in circles) as photographed through camera.



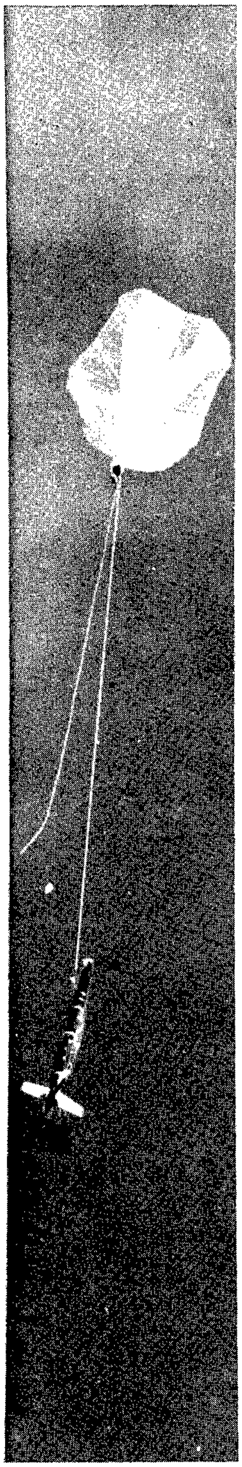


IGY advance station on Ross Island, Antarctica.

● ANTARCTICA

In the Antarctic, the Navy is supporting the establishment of IGY stations by supplying ships, personnel, and equipment. Studies being conducted by IGY scientists there encompass whistling atmospherics, cosmic rays, and seismological and meteorological phenomena. IGY exploration and research in Antarctica will do much to enhance our limited knowledge of this increasingly important continent.

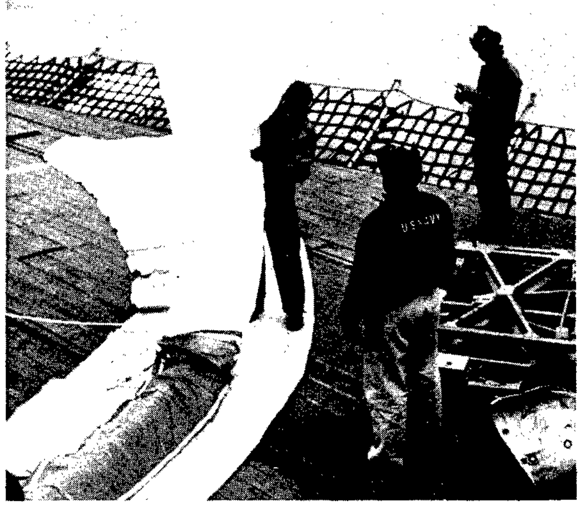
The USS GLACIER in McMurdo Sound, Antarctica.

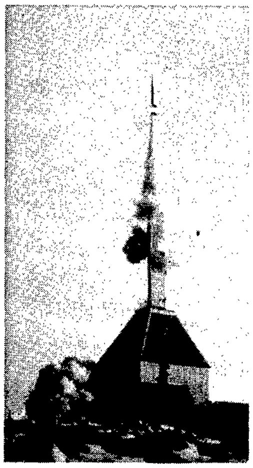


● COSMIC RAY PROGRAM

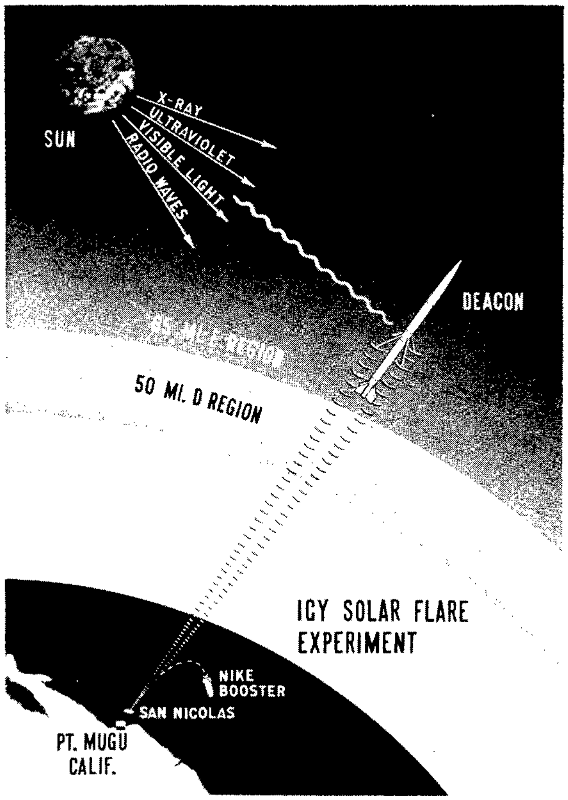
For years, scientists have been seeking explanations for the large decrease in cosmic-ray intensity that occurs during some magnetic storms, the world-wide variation of cosmic-ray intensity with the sun-spot cycle, and sudden large increases of cosmic-ray intensity that are observed an hour or less after the beginning of the occurrence of solar flares. During the IGY the Navy will extend its regular cosmic-ray program, utilizing combination balloon and rocket flights in different latitudes and longitudes during periods of increased solar activity. Rockoon (rocket-balloon) firings are scheduled for both the Pacific and Antarctic areas.

Below, a SKYHOOK balloon is inflated for launching at sea. Left, the balloon, lifting a Deacon rocket, soars skyward. The rocket is fired at an altitude of about 70,000 feet and rises to a height of about 60 miles.





An Aerobee-Hi is fired at Fort Churchill, Manitoba, Canada.



Representation of the flight of, and information gathered by, a Nike-Deacon rocket.

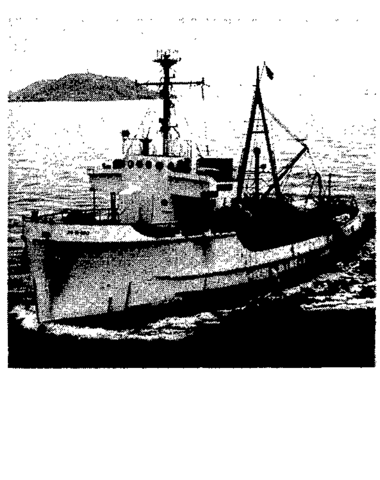
● ROCKET PROGRAM

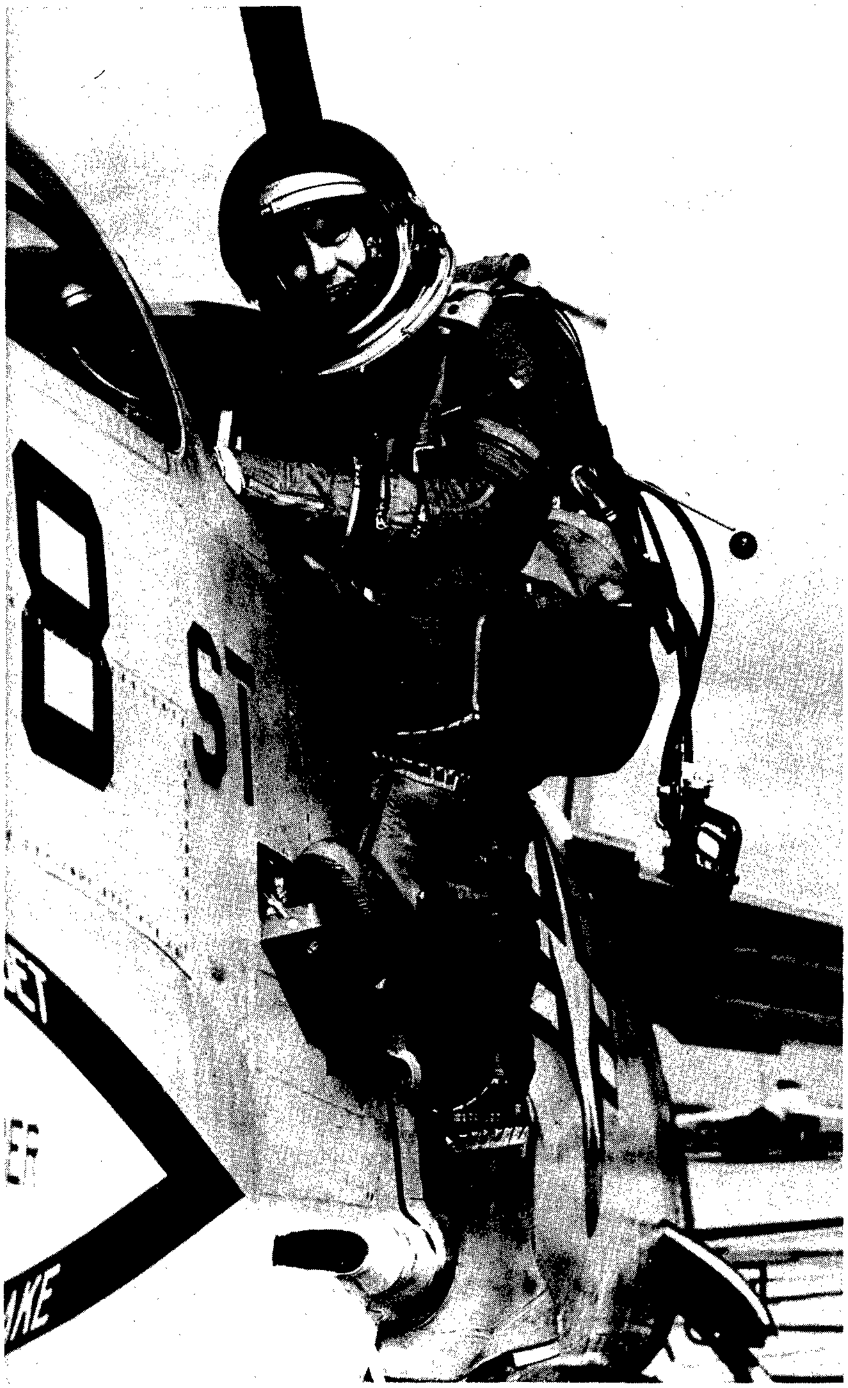
Instruments carried aloft by IGY rockets will obtain data on solar ultraviolet and X-radiations absorbed by the atmosphere at high altitudes, chemical and ion composition of the upper atmosphere, auroral particles and ionospheric current flows, and the earth's magnetic field. Nike-Deacon rockets will be fired at Pt. Mugu, California, and Aerobee-Hi rockets at Fort Churchill, Manitoba, and White Sands, New Mexico.

● OCEANOGRAPHY PROGRAM

The objective of the IGY Oceanography Program is (1) to learn more about sea-level changes and their relationship to other phenomena of the ocean and to atmospheric conditions, (2) to study the circulation of the water moving northward from Antarctica into the Atlantic and Pacific Oceans, and (3) to obtain submarine geophysical profiles of the eastern and western parts of the Atlantic Ocean and in the central and eastern parts of the South Pacific Ocean.

Scripps' research ship HORIZON.





Wearing a full-pressure high-altitude flight suit, a naval aviator emerges from an F8U "Crusader" following a test flight.

Long-Range Studies of Naval Aviators

CAPT Ashton Graybiel, MC, USN
Naval School of Aviation Medicine
Pensacola, Florida

In the field of military aviation medicine, doctors are regularly called upon to state that for a given flight, or for flights over a given period of time, a pilot is physically qualified and "mentally adapted" for certain undertakings. In effect, such requests imply that we are able to understand all of the factors incidental to the pilot's task and take them properly into account. Of course, we can't do all this—too many factors are involved. However, we are improving our ability to make such judgements. One of the ways we are doing this is by analyzing as much medical, psychological, and performance data as we can collect on naval aviators throughout their careers.

An important start toward compilation of this data was begun in 1940 at the School of Aviation Medicine at Pensacola, Florida. That summer, investigators sponsored by the Bureau of Medicine and Surgery, the Civil Aeronautics Authority, and the National Research Council began making clinical studies and certain physiological and psychological tests on a group of student aviators and flight instructors. The group tested consisted of 88 officers and 968 cadets. The great majority of the cadets were college graduates, but a number had finished only two years of college, and 33 had finished only high school. The average age of the instructors and cadets was 24. All were considered to be in splendid physical condition.

Although the purpose of the project—called the Pensacola Study—was to determine if there was a relationship between the test findings and the success of the students in training, the material obtained was basic to long-range studies of naval aviators made during later years.

1950 TO 1952 FOLLOW-UP STUDY

No attempt was made to restudy this group of men until 1951. At that time, investigators interested primarily in medical aspects of the students' case histories, particularly from the cardiovascular point of view, repeated the tests conducted during the Pensacola Study. Dr. John M. Packard and Dr. John S. Graettinger of the School of Aviation Medicine traced all but 17 of the original group and reexamined most of the men who were still alive. The important findings are summarized in Figures 1 and 2.

Non-Completers—Two hundred and three students who were tested in 1940 failed to complete flight training. Of these, 131 failed because of poor performance during check flights, 31 dropped out at their own request, 19 were eliminated following disciplinary action, 16 failed to

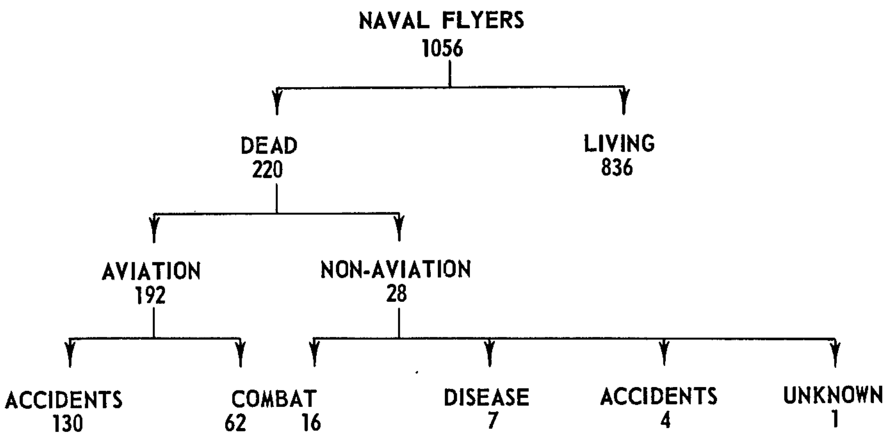


Figure 1—Causes of deaths occurring over a period of 12 years among group of men who entered naval flight training in 1940.

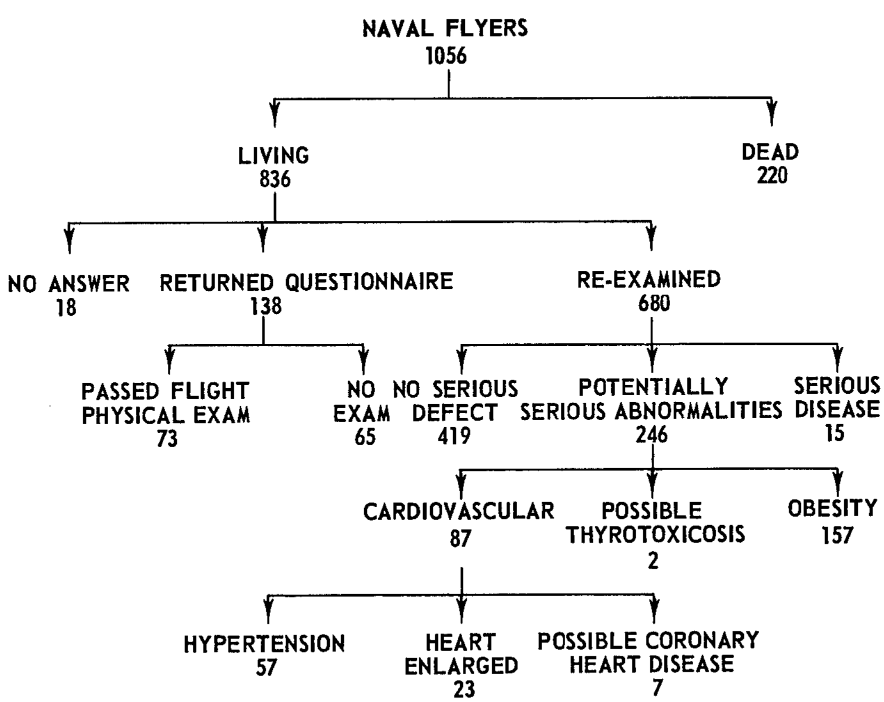


Figure 2—Diseases and disorders found among a group of naval flyers and former flyers 12 years after they entered flight training (in 1940).

meet physical standards, and the remaining 6 died during flight training. Eighty-eight of these non-completers later regained flight status as flight crew members or as pilots in other services, and most of this group remained in flight status throughout World War II. A few of the non-completers found their way back into the Navy as aviators. In fact, the aviator with the largest amount of flight time to his credit was a non-completer.

Morbidity and Mortality due to Disease—It is truly remarkable that only 7 of the 1,056 aviators died of disease during the 12-year period. This death rate is less than half of that of men of comparable age in the general population, and it stands in sharp contrast to the number of deaths caused by disease in former wars. When one considers that these aviators were exposed to the stress and strain of warfare in areas where infectious and exotic diseases were relatively common, the finding is all the more noteworthy.

At the time of reexamination only 15 men of 680 examined revealed symptoms of severe illness—a lower incidence than would be found among civilians in a comparable age group. However, a relatively large number, 246, showed symptoms of potentially serious conditions—mainly, hypertension and coronary heart disease. This finding raised the question of whether heart diseases develop earlier in flyers than in non-flyers. To find the answer, a special study was conducted.

In carrying out the first phase of this study, the survivors of the original group were divided into three categories on the basis of their flying experience: First, the non-flyers (men who failed in training and did not go on with flying); second, those who flew for a relatively short time, that is, only during the war period; and, third, those who flew for a relatively long time, at least five years. A careful comparison of the cardiovascular status of the men in these three groups revealed no substantial differences. However, as the groups were relatively small, it was decided to expand this aspect of the study to include all of the flying and non-flying officers in the Navy from 1950 to 1952. In every age group fewer pilots died of heart diseases than non-pilots. A further comparison was made in which the flying and the non-flying naval officers were considered as two occupational groups, and the annual death rates for coronary disease in each group were compared with the rates for white males of comparable age in the general population, and for physicians (Table 1). The death rates for flyers was about the same as that for white males of comparable age, but lower than the rates for non-flying officers and physicians, especially in the age range of 45 to 54.

The explanation for this unexpected finding is not to be found in denying the existence of flying stress. A partial explanation may be that the professional military aviator is a person not unduly anxious or fearful of flying. If he were, he would probably have dropped out of the program at an early stage. Also, it can be shown that, on the average, the military pilot flies a little less than one hour a day, and in the majority of his flights the stresses are not great. Moreover, when he does go through a period of intensive flying, the period is usually followed by rest and recreation, which give him an opportunity to recover. This is in accord with the concept that a man recovers rather quickly from severe stress of short duration and that the more harmful effects are induced by prolonged exposure. This fact was brought out beautifully in studies carried out under actual conditions of warfare in Korea.

The general conclusion we have reached—that the development of heart disease or deaths from heart disease among naval aviators is no greater than in the population as a whole—is a very important one.

Electrocardiograms—The electrocardiographic findings were of particular interest to us. When these records were obtained at the time of the original examinations in 1940, they could be placed in one of three general categories: (1) within normal limits, (2) frankly abnormal, and (3) "borderline" in abnormality. That the fliers who revealed frankly abnormal electrocardiograms in 1940 were not removed from the training program is thus explained: The investigation made at that time was clearly of an exploratory nature, and the men who volunteered as subjects were informed that none of the findings would be used to influence their careers in aviation. Were it not for this fact, those with definite electrocardiographic abnormalities would have been dropped from the program. Moreover, many of those with so-called borderline abnormalities would have come up for special consideration before a medical examining board.

Among those who revealed abnormal electrocardiograms in the first examination, one died of an accidental injury resulting from flying; it could not be determined whether he was in control of the aircraft at the time. Of particular interest were three instances of bundle-branch block, which is usually associated with heart disease. When the men having this condition were reexamined, branch-block was found to be present, as before. However, none of the men had complaints referable to the heart, and their careers as aviators had not been affected in any manner. While these three cases do not provide enough evidence for generalizations, they do indicate that such conditions may not be incompatible with strenuous careers in aviation or other activities.

Electrocardiograms suitable for analysis were obtained from 645 men at the time of reexamination. Ninty of these men had originally exhibited borderline abnormalities. It is noteworthy that not one of the 90 men was found to have symptoms of heart disease during the follow-up period. Furthermore, in 59 of the 90 men the borderline abnormalities had disappeared, and in the remaining 31 men they had not become more abnormal. On the other hand, there were instances in which the original electrocardiogram was normal and the second electrocardiogram was abnormal. Out of 19 such cases only one was clearly associated with other evidence of heart disease.

In order to give more meaning to these findings, the electrocardiographic data were compared with those obtained for 2,600 school children 18 years of age and younger. The results show that about the same proportion of abnormalities exist in each group. Although a detailed comparison has not been made, it is estimated that slightly more abnormalities and borderline abnormalities occur among the school children than among the aviators.

TABLE 1

Number of deaths (per 100,000 individuals) resulting from coronary heart disease for certain groups of males.

Group	Age		
	25-34	35-44	45-54
White Males (representing general population)	6.8	44.1	159.2
Physicians	5.5	66.8	227.66
Flyers	7.3	32.0	165.4
Non-Flyers	8.0	76.4	335.3

TABLE 2

Comparison of number of deaths (per 1,000 individuals) occurring among naval aviators and non-flying naval officers.

Period	Cause of Death	Flyers		Non-Flyers
		Group under study *	Entire Navy	
World War II	All causes	51.8	49.3	6.6
	Combat only	22.2	10.0	3.6
Peacetime 1946-51	All causes	3.5	9.1	1.8

* This group comprised 853 naval aviators.

From these studies we were able to draw two general conclusions: First, that our findings offer excellent testimony to the high degree of reliability of the electrocardiographic method. This is emphasized by the fact that in obtaining the records different types of electrocardiographs were used under a wide variety of environmental circumstances and by many different technicians. The second conclusion is that the abnormal and borderline abnormal conditions revealed by the electrocardiograms do not necessarily indicate heart disease or stages in the transition from normal to abnormal heart conditions.

Mortality due to accidental injury and combat—In Figure 1 it was shown that 192 of the fatalities that occurred within the original group tested were associated with flying. Of these, less than one-third occurred in combat. Comparative studies were carried out and some of the results are summarized in Table 2. It will be noted that during wartime the death rate for fliers was more than seven times the rate for non-flying officers. Although the death rates are much lower since the end of World War II, naval aviators still have a death rate in peacetime five times greater than that of non-flying officers. Indeed, these figures show that military aviation in peacetime is as hazardous for the aviator as combat duty in wartime is for the non-flying officer.

Upon reaching the age of 40, the naval aviator enjoys a brief respite. At that time he is automatically reclassified. However, in most instances this does not coincide with an abrupt change in duty because the transition from operational flying to administrative duties begins much earlier. Nevertheless, the transition is characterized, among other things, by a fall in the death rate. For example, in 1950 the death rate for naval aviators 40 years of age was only two-thirds that for aviators 39 years of age. This was so despite the fact that for non-flying officers 40 years of age and older the death rate rises. The aviator enjoys only a brief period around the age of 40 when the death rate is fairly low; the rate then begins to rise because of the effects of aging.

1957 TO 1958 FOLLOW-UP STUDY

At the present time, Dr. William Harlan of the School of Aviation Medicine is carrying out a second follow-up study. This work promises to equal in thoroughness and importance that done from 1950 to 1952.

Responses to requests for cooperation in this investigation have been enthusiastic. This is because the men feel that they are contributing to something worthwhile and because they are interested in learning more about their state of health. Many of the men who are still in the service have voluntarily come to Pensacola from distant places for the medical examination. And many of those who are now in civilian life have traveled hundreds of miles at their own expense to cooperate in the investigation. Although the work is nicely underway, a complete analysis of the data has not been made because the reexaminations have not yet been completed. Nevertheless, a summary of Dr. Harlan's findings and impressions up to this time can be given.

It is estimated that 700 of the original 1,056 who were tested are alive and that their mean age is 44. Of these, 533 have been contacted, and 61 have been reexamined. About one-third of the members of the group who are still living are on active duty in the military. Most of them are in the Navy, 13 are in the Air Force, and 3 are in the Army. Although most of those who still have flying status do only enough flying to maintain proficiency, there are a few notable exceptions. One of these is a naval aviator who checked out in jet fighters at the age of 39 and now flies F8U s and F11's. In general, those members who are now in civilian life have had successful careers, although their environments range from skid-row to the governor's palace. Twenty are flying with commercial airlines and eight are physicians or dentists. Many are in business and industry.

Generally speaking, the men who have remained in the military are in better health than those who have not. For example, many of the civilian members have complained of gastrointestinal ailments, and X-rays have shown that at least 7 percent of them have had peptic ulcers. In the military portion of the group only one person thus far has been found to have an ulcer. The civilian members have gained more weight than the military members, and they are less fit physically. Many have indicated that they have experienced "emotional changes," marital problems being one of their principal difficulties. It is interesting to note that hypertension is still relatively rare among both the military and civilian members. Indeed, there seems to be little correlation between the blood-pressure levels obtained on the initial examination and the subsequent development of hypertension. This finding may well prove to have real value when a restudy of the physical standards we set for naval aviators is made. Coronary heart disease, on the other hand, was found to occur relatively frequently; of those members reexamined thus far, no less than 7 have had frank myocardial infarction* and 2 others have angina pectoris. It is noteworthy that at the time of the examination in 1952 the electrocardiograms for these men were normal. It is also noteworthy that none of those men who revealed electrocardiographic abnormalities in 1952 now shows symptoms of, or has developed, heart disease. Undoubtedly, the results of this second follow-up study will not only prove to be very significant, but also will point the way to important future investigations.

Through the extension of such long-range studies as the ones described here, we hope to learn much more than we now know about the medical and psychological problems of the naval aviator and what might be done to solve them. The importance of this study rests on the following facts: Few individuals possess the qualifications to fly modern aircraft successfully. The aviator is trained at great cost. He is immediately responsible for the lives of others and for valuable equipment. And, as a key component of a weapons system, he is essential to the security of the nation.

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*Destruction of a portion of the heart muscle due to a shutting off of the blood supply. The usual cause for this is the formation of a blood clot in the artery which normally supplies that portion of the heart with blood.

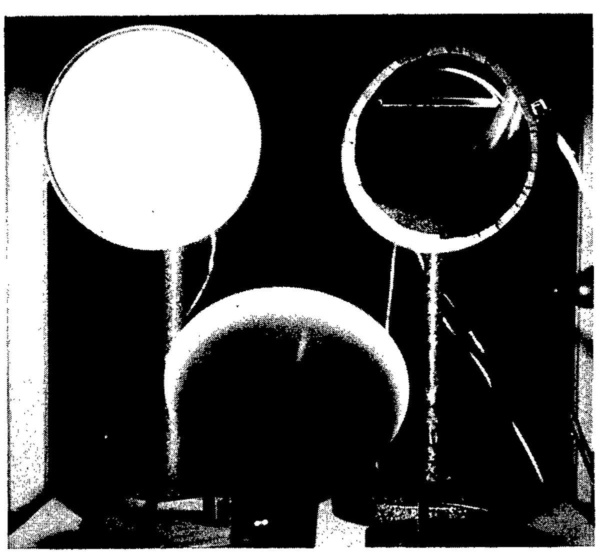
The new TV screen and Dr. Charles Feldman, who developed it.

Transparent-Film TV Screen

A revolutionary new television screen developed recently at NRL will permit viewing of television in bright daylight with little loss of contrast. The new screen also provides a new simplified approach to color television and is expected to lead to the development of three-dimensional viewing.

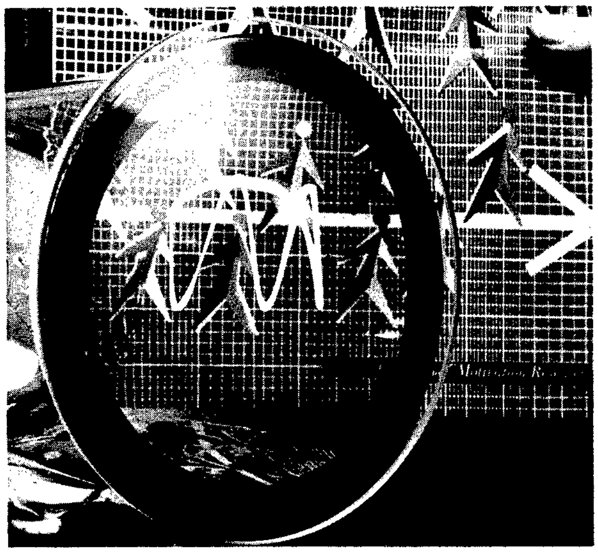
The basis for the screen is a process for depositing the phosphor on the face of the tube in the form of thin transparent films in place of the opaque white powders now used. The films are more rugged than the powdered screens, can be made brighter because they do not burn out as easily, and present a much sharper image.

The improved daylight viewing of black and white television comes about because of the naturally improved contrast obtained with transparent films. The powdered surface in present tubes is a good reflector, and in strong sunlight the reflection is brighter than the picture. With the transparent film, sunlight goes through the film and is lost in the darkened interior of the tube, so that contrast is maintained even with bright daylight shining directly on the tube. Use of the film also produces a sharper picture because eliminating the powdered screens also



Effect of light shining on a conventional TV tube (left) and a tube containing a transparent screen (right). Although a pattern is displayed on both screens, only that on the new screen is visible.

The June 1956 cover of Fortune Magazine viewed through the new TV screen. The clarity of the white pattern, which is displayed on the screen, and of the magazine cover, seen through the screen, illustrate the screen's transparency.



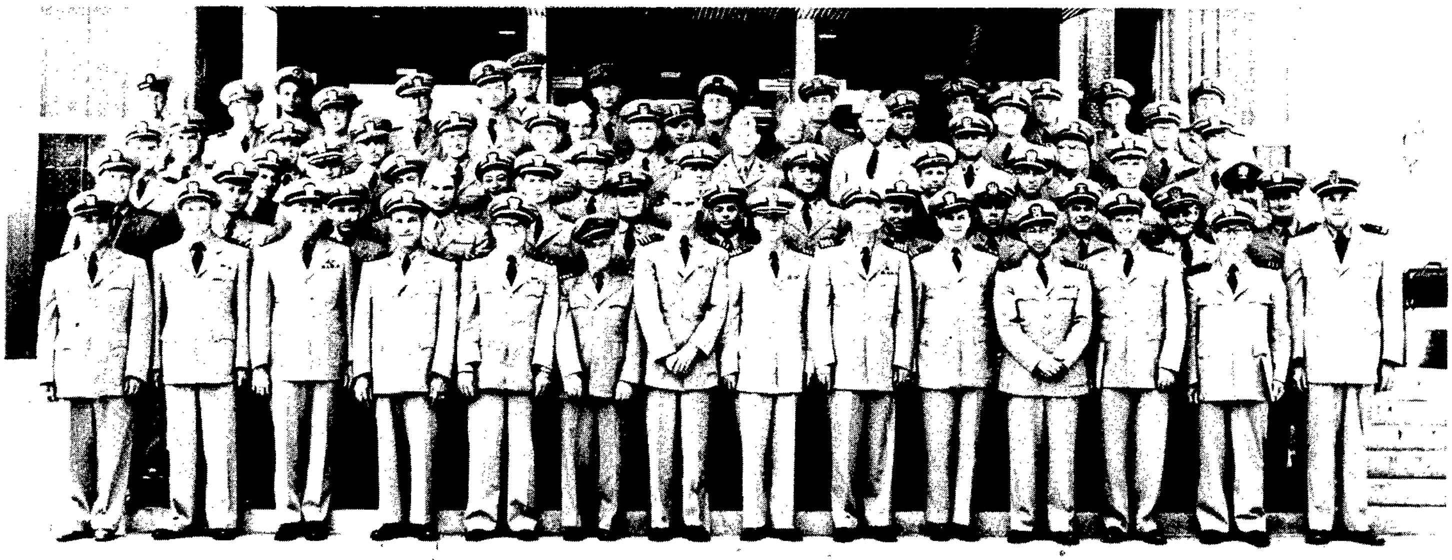
eliminates the grainy texture that results in an image with hazy borders.

Both of these advantages can be applied to the present form of color television; but the transparent films also provide the basis for a completely new approach to the problem. Films that create different colors can be deposited one atop another and lighted separately or mixed by controlling the speed or the direction of the electrons in the tube. By using one film of each of the three primary colors the complete color spectrum can be obtained by proper mixing. Tubes with several combinations of two primary colors and blends of these two colors are in successful operation; and tubes with all colors are in the experimental stage.

This work was started as part of an Office of Naval Research program for simplifying aircraft instruments. The goal is to simplify the operation of jet fighter planes, to reduce the training time of pilots, and to help them get the maximum performance from their planes. Part of this aircraft development involves replacing the present windshield with a thin transparent television tube. The pilot will then be able to see through the windshield, as usual, and receive information from instruments at the same time and in the same spot.

Pink Sand

Through ONR sponsored research a technique has been developed for preserving blood indefinitely. The technique utilizes liquid nitrogen, by means of which the temperature of the blood is reduced to about -90° C. In its frozen state the preserved blood looks like pink sand. No deterioration or change in properties of the blood occurs when it is reconstituted and administered to patients. Before this discovery was made, blood could be preserved only 20 to 30 days.



Participants at the Seminar on Research Methodology.

Row 1—Van Echo, Blackmore, Baier, Kupferberg, Cronin, Jacobziner, Hicks, Wollpert, Boyce, King, Trumbull, Gabrielson, P. Johnson, Biehler.

Row 2—Lackey, Doolittle, Levine, Trott, J. Spencer, Moore, Ovian, Westfall, McNeely, Pfanner, Powell, D. Spencer.

Row 3—Bollinger, Newcomb, Macek, Lindsey, Goldberg, Kyser, Peterson, Marshall, Box, Kleinsasser, C. Johnson, Shull.

Row 4—Chellevold, Greenwood, Messer, Matteson, Maplethorpe, Howland, Brinkman, Sandfort, Bush, Walker, Heckler.

Row 5—Kizzek, Case, Moreland, Lambert, Hasbach, Celis, O'Malley, Hubbard, Flint, Biddle.

Row 6—Abel, Jensen, Libbel, Secrest, Hodges, Cherrek, Fitzpatrick, Myers, Whiteneck, Hartmen.

On the Naval Research Reserve

Seminar on Research Methodology

The third annual Seminar on Research Methodology took place in Columbus, Ohio, during the period 16 to 29 June 1957. This seminar was conducted by NRRC 4-7, under the auspices of the Office of Naval Research. CAPT Oram C. Woolpert, USNR, Commanding Officer of the local company, was seminar chairman. Sixty-five Navy, Air Force, Army, and Marine Corps officers attended. Most of the sessions were held in the air-conditioned Ohio Union Building on the Ohio State University campus. Officers were housed in a nearby dormitory.

At the opening session the Chief of Naval Research was represented by his Special Assistant for Research Reserve, CAPT A. S. Boyce, USNR, accompanied by CDR John K. Hicks, USNR, Research Reserve Training Officer. LCDR George Cronin, USN, was present in his capacity as Research Reserve Assistant to the Commanding Officer, ONR Branch Office, New York. CAPT Daniel Bontecou, USN, Commander, Naval Reserve Areas 4-5, officially represented the Commandant, Fourth Naval District. CAPT James H. Jordan, USN, Professor of Naval Science, Ohio State University, also addressed the group.

Following the pattern of previous seminars, a broad view of problems and approaches in various fields of research was given. Emphasis was placed on methods, rather than on solutions to specific problems. Examples of research were drawn from the physical, biological, and social sciences, and included applications of particular interest to the Navy. Speakers were principally from the University faculty and the staff of Battelle Memorial Institute.

Audience participation was lively throughout the seminar. Problems were assigned which attendants worked on in small groups and later discussed in general sessions. One of these problems concerned the construction of a flow diagram for a hypothetical computer; another problem involved the study of procedures for improving performance for a piece of fire control apparatus which operated satisfactorily in field tests but failed to perform satisfactorily in the Fleet.

The first morning was devoted to Naval matters. In the afternoon, Dr. Tibor Rado, research professor in the Department of Mathematics, Ohio State University, discussed fundamental research in mathematics. He emphasized some of the problems inherent in the development of formal mathematical models for practical applications and the communication problems of research. The program for the second day developed the theme of the use of statistics and computers in research. A general consideration of statistics as a common language was presented, followed by a discussion of the use of statistics in problems of agriculture and the behavorial sciences.

In the afternoon, a discussion of programming of problems for computers was conducted by the director of the Numerical Computation Laboratory of the Ohio State University Research Foundation. A problem was assigned to the group for solution and discussion.

Nuclear-reactor development and related activities provided the framework for the next day's session. The problems and the challenges of the future were pointed out, particular reference being made to some of the managerial problems connected with the uses of atomic power. A field trip was made to the Nuclear Energy Center of the Battelle Memorial Institute, and a tour of the reactor and hot-cell facilities was conducted for the members of the group.

In a somewhat different vein, the fourth day's program was devoted to problems of organization and management, with specific reference to the utilization and organization of research personnel. Another day was spent touring the research laboratories of the Battelle Memorial Institute in Columbus.

Research in education, such as on subjects being taught in the secondary and high schools and on the composition of school classes for the most effective learning experience, was also discussed during the first week of the seminar.

Monday of the second week was devoted to problems of space travel. This subject was discussed by a panel composed of an aeronautical engineer, a fuel engineer, a physiologist, and a psychologist. The general feeling seemed to be that the possibilities of space travel are much better than they appeared to be a year ago. The topics of discussion included the ballistics of the missile, propulsion systems, the physiological aspects of the environment, and psychological aspects of the tasks facing the crews of the space ship.

On the following day a panel discussed problems of research on nutrition, infectious diseases, and dentistry. The discussions were followed by demonstrations of new techniques in dentistry and a panel discussion by the speakers. The need for an interdisciplinary approach to some of the broad problems of biological research was stressed.

A day was devoted to problems of systems analysis. One of the topics covered was operations research. This was discussed by the Ohio State University Operations Research Group. Problems of laboratory simulation of systems, with emphasis on the simulation of an air-tractive control system, were presented by the Ohio State University Laboratory of Aviation Psychology. Some aspects of partial simulation of systems were also considered. A typical human engineering design problem was presented for group discussion.

A day was also spent on research in mental health, with participation by personnel of the Psychiatric Institute and Hospital of the Ohio State University Health Center. The contributions of psychiatry, neural pathology, neural physiology, experimental and comparative psychology, biochemistry, physiological psychology, neural endocrinology, and bio-physics were discussed.

The last day of the seminar was set aside for talks by the officers in attendance. One of these speakers was CAPT A. B. Metsger, USN, Deputy and Assistant Chief of Naval Research. CAPT Metsger discussed the work of the Office of Naval Research.

CDR Rode Honored

CDR Rode

CDR Norman F. Rode, USNR, Commanding Officer, NRRC 8-3, College Station, Texas, was recently presented the Faculty Distinguished Achievement Award by the Association of Former Students of Texas A. and M. College ". . . in recognition and appreciation of his ability, personality, and methods, which have resulted in distinguished achievement in teaching and in the inspiration of his students for the year 1957."

A check of $1000.00 accompanied the award.

In civilian life CDR Rode is a faculty member in the Engineering Department of Texas A. and M. College, a registered professional engineer in the State of Texas, and a vice president and member of the Board of Directors of the American Institute of Electrical Engineers.

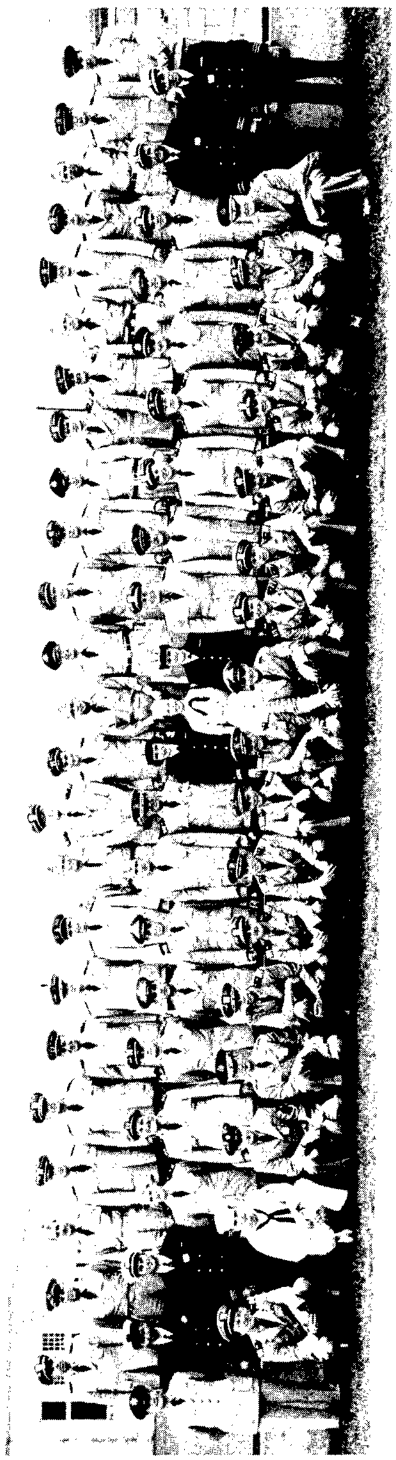
Nuclear Sciences Seminar

The Fifth Annual Nuclear Sciences Seminar for Naval Reserve training was held at Brookhaven National Laboratory, Upton, L.I., N.Y., from 26 May to 8 June 1957. The seminar was given by NRRC 3-9 in collaboration with the Brookhaven National Laboratory, and was sponsored by the Office of Naval Research. The program, entitled "Life Sciences and Atomic Energy," was attended by sixty Reserve officers, most of whom were of the Navy, but some of whom were of the Army and Air Force. Only Reserve officers having a background in the life sciences were selected for attendance.

The program Committee, which consisted of CAPT Robert A. Conard (MC) USNR, Chairman, and LCDR James S. Robertson (MC) USNR and LCDR Lawrence V. Hankes (MSC) USNR, was pleased by the large number of outstanding scientists, both from outside scientific organizations and from Brookhaven National Laboratory, who accepted invitations to speak at the seminar.

The program covered a broad area of material in the life sciences and in atomic energy. Lectures were presented on nuclear data review; radiation sources and hazards; radiation effects, acute; radiation effects, long term; uses of radiation in diagnosis, therapy and research; radiation protection; and civil defense.

The Commanding Officer of Company 3-9 is CAPT John S. Medd, USNR, and the administrative officer representing the Commandant of the Third Naval District for the seminar was CAPT Frederick H. Williams, USNR.



Reserve officers attending the Fifth Annual Nuclear Sciences Seminar.

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LAST MONTH WITH "VANGUARD"

Signals from the Moon have been picked up by the Blossom Point, Maryland, MINITRACK test facility, one of 10 stations that will track the scientific earth satellite during the IGY. The Blossom Point facility, which is operated by engineers from the Naval Research Laboratory, has conducted several successful test "pick ups" in cooperation with engineers at the U. S. Army Signal Engineering Laboratories at Fort Monmouth, New Jersey.

Using the giant radar transmitter Diana, the Army Signal Corps engineers have been bouncing signals off the Moon. These signals are then picked up by NRL's highly sensitive MINITRACK radio tracking equipment at Blossom Point. The purpose of the tests is to perfect a technique by which the operation of all of the satellite tracking stations in the Western Hemisphere can be tested as soon as they have been completed and placed in operation. The technique can also be used to calibrate satellite tracking stations set up by amateurs in various parts of the Western Hemisphere, Africa, Europe, and the islands of the Pacific.

The receiving equipment being used in the tests is the Mark II MINITRACK, which is being designed by NRL for use by volunteer radio tracking stations.

VANGUARD engineers and technicians at Blossom Point have reported that many interesting results have been obtained from various tests conducted at the station. For example, the station has received signals from the sun and other solar bodies, and evaluation tests have been made by sending signals from aircraft and balloons to the ground equipment.

The Diana radar transmitter, Fort Monmouth, New Jersey.

In This Issue

COVER PHOTO: The moon-position camera, which is being used to make important determinations during the IGY, and its inventor, Dr. William Markowitz of the Naval Observatory. See picture set beginning on page 9.

RESEARCH REVIEWS reports highlights of technical progress in research by Navy laboratories and contractors and the development of important naval research facilities. Articles which meet these broad criteria and possess a good degree of readability are welcomed. Manuscripts and changes of address should be sent to Code 740, Office of Naval Research, Washington, D. C. Research Reviews is listed for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. Subscription price: $1.50 per year in U. S. and Canada; $2.00 per year, foreign; $.15 per individual copy. Approved by the Bureau of the Budget, 28 February 1955.