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RESEARCH REVIEWS

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WASHINGTON, D. C.

COVER PHOTO: Navy radio-controlled helicopter developed by Kaman Aircraft Corp. The man in the foreground is actually flying the plane, but because the 'copter is the only one of its kind a pilot rides in the cockpit—just in case. (Kaman Aircraft Photo).

Research Reviews endeavors to report briefly 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.

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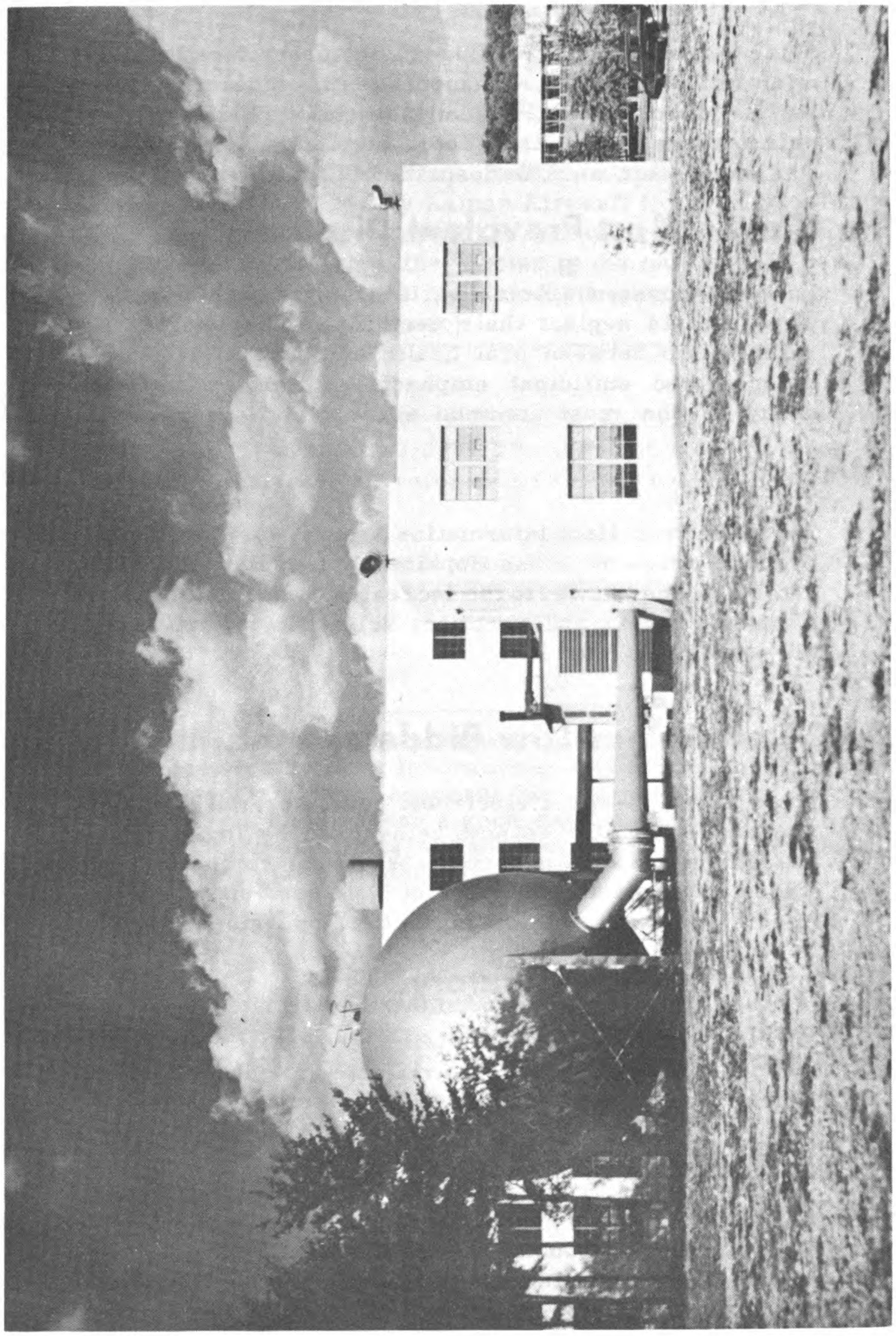


The Supersonic Wind-Tunnels at DTMB

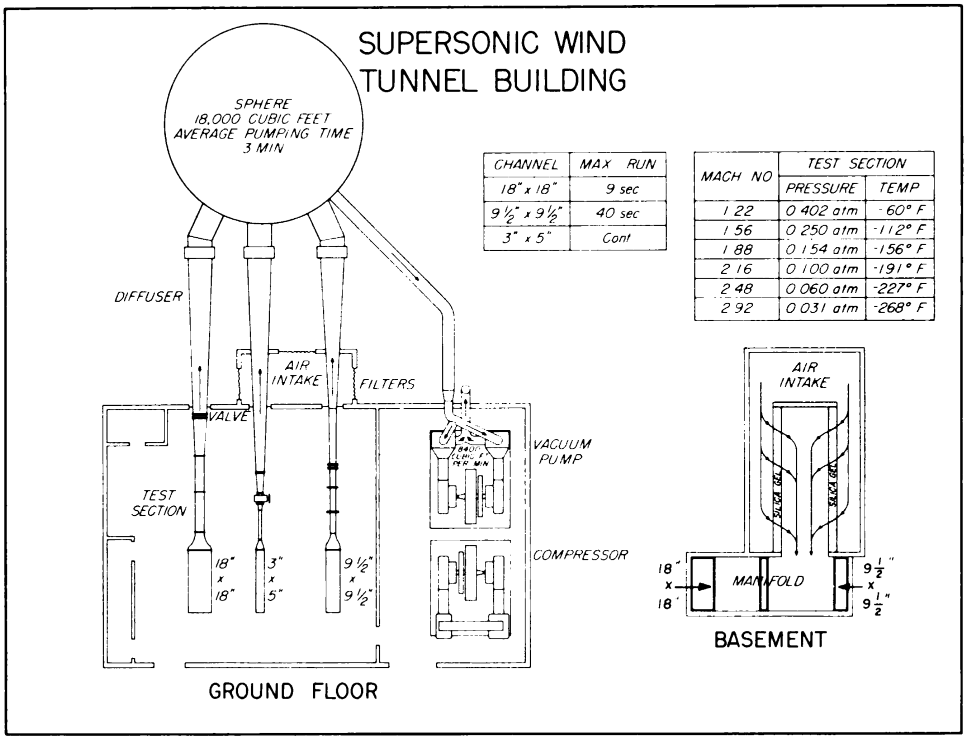
Inside a small white building on the grounds of the Navy's David Taylor Model Basin (DTMB) at Carderock, Maryland, a giant vacuum pump chugs prodigiously. Seconds later, when its two 36-inch pistons have produced the required vacuum in the 32-foot steel sphere at the rear of the building, a switch closes, a valve opens and for a few seconds air shrieks through a small tunnel at speeds up to nearly three times that of sound. During this brief burst of enormous speed, instruments record the behavior of a little model mounted inside the tunnel and exposed to the ferocity of the airstream.

After the "blow," scientists begin the painstaking task of analyzing and evaluating the data. Some of this information will fall within the purview of the known and understood; some of it will not admit of immediate explanation by existing theory. It was because supersonic flight offered such a promising avenue of research that this installation was established and entered upon full-scale operation in September, 1950. The collated findings of DTMB aerodynamicists are transmitted to the Bureau of Aeronautics, where design engineers will translate them into improvements and refinements in tomorrow's naval aircraft.

Although DTMB has always been thought of primarily as a ship-model establishment, and its landscape is dominated by the 2775-foot towing tank, the air testing facilities are steadily increasing in number and importance. There are now three wind-tunnel installations: a subsonic one, a transonic one recently completed and not yet in full-scale operation, and the supersonic one that is described here.

The over-all design of the supersonic laboratory is simple enough, as can be seen from the diagram. Close scrutiny of the pump room and the foundations of the building reveals that the two pumps are mounted on monolithic concrete pilings isolated entirely from the rest of the building structure—they go down, in fact, to bed rock, and they each weigh 400 tons. By this means virtually all vibration from the pumps is eliminated—an important consideration since even a slight extraneous vibration in the test chambers could cause observations to go awry. The pumps themselves are of medium size: the larger, a single-stage double-acting (thrust and return strokes both utilized) machine, has two pistons three feet in diameter with 18-inch strokes. This is the "work horse" of the installation; it can pump 8400 cubic feet of air per minute. The other, a two-stage double-acting device, has smaller pistons and its valves are so arranged that it is a vacuum pump or a compressor according to the needs of its users. In addition to serving as an auxiliary for its hard-working companion, it is used for diverse chores and experiments that require large-scale vacuum or pressure. Both pumps are driven at 200 revolutions per minute by 400-horsepower motors, and it is here that the economy of the "intermittent" type wind tunnel is effected. If the 18- by 18-inch channel, for example, were run continuously, about 8000 horsepower would be required. Hence, by restricting the time of operation to a bare minimum, an enormous saving is made.

The vacuum is applied to the actual tunnels through long conical subsonic "diffusers" that extend from the sphere through the concrete



CHANNEL	MAX RUN
18" x 18"	9 sec
9 1/2" x 9 1/2"	40 sec
3" x 5"	Cont

MACH NO	TEST SECTION	
	PRESSURE	TEMP
1 22	0 402 atm	-60° F
1 56	0 250 atm	-112° F
1 88	0 154 atm	-156° F
2 16	0 100 atm	-191° F
2 48	0 060 atm	-227° F
2 92	0 031 atm	-268° F

walls of the building to the three test chambers. Each of these test chambers is made of reinforced steel, and the tests are watched or photographed through thick plates of glass in the chamber walls. Almost all tests are photographed, as a matter of course, by the Schlieren process (see Page 4) which records the air-flow patterns set up by the model.

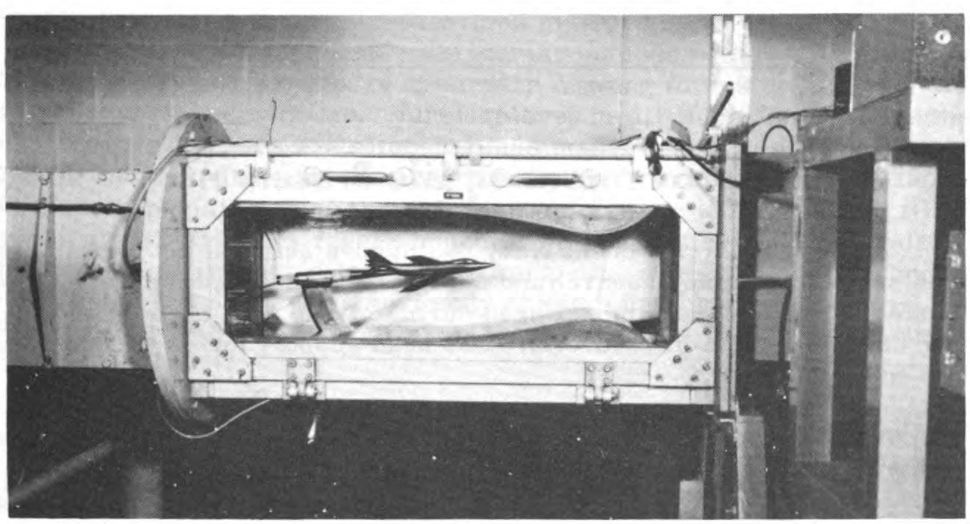
The cross-sections of the three chambers are, respectively, 18 by 18 inches, 9-1/2 by 9-1/2 inches, and 3 by 5 inches. The smallest one, which can be operated continuously by the 400-horsepower pumps, at Mach Numbers up to 2.9 if desired, is used principally for research on wind-tunnel design, being too small for most models. The medium-sized tunnel is used for research, experimental, and proof testing, and the largest one chiefly for developmental testing. All of them have numerous interchangeable air contour surfaces or "nozzles" whose shapes remind one of wing cross-sections. Actually, they make a giant two-dimensional Venturi tube of the wind tunnel, and changing them modifies the speed and pressure of the air inside. The pressure in the test chamber, incidentally, is extremely low during a blow—it may plunge to 0.03 atmosphere—and the walls of the tunnels can be seen to collapse slightly despite their ruggedness. As one might well suspect, there is danger that, under such stresses as these, the glass observation ports will implode, and all personnel keep a respectful distance during the brief runs.

The 18-inch tunnel is almost entirely automatic. When the vacuum in the sphere reaches a predetermined value, a vacuum switch triggers an electric circuit which initiates the entire program. A blow can be programmed according to its peculiar requirements and then carried out without direction as many times as may be desired. One model has "flown" over a quarter million miles in the test chamber—or from here to the moon!

Models are mounted in the tunnels on sturdy adjustable supports which are positioned and controlled from the outside; the angle of attack can be varied thus to within 0.01 degree over a 24-degree range. Within the models tiny strain-gage balances are strategically placed to detect changes of all kinds. These expensive balances, which for the most part must be specially built for each test, are connected by armored cables to strain recorders that provide a permanent record on paper of the progress of the experiment. This information is supplemented by data from pressure gages and by the Schlieren photographs for the taking of which each tunnel is equipped with heavy optical mirrors.

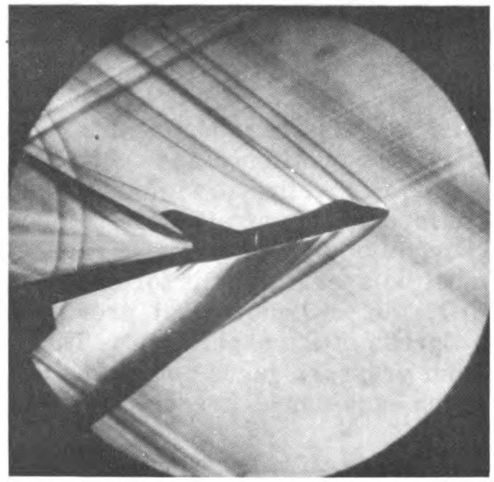
Since only one tunnel can be used at a time, an electrically controlled gate system is provided to make it impossible to use any tunnel unless the other two are sealed. This arrangement permits the work of setting up an experiment to proceed in one channel while another channel is running.

When air containing water vapor passes from the "throat" (narrowest part of the nozzle) of a supersonic wind tunnel into the divergent area just ahead of the test section, it is greatly expanded and its temperature is greatly lowered, all in a few thousandths of a second. This causes a sudden supersaturation—sometimes as great as 900 percent. When condensation occurs, it causes a severe shock wave which would render the test useless if it were not prevented. Calculation of the degree of dryness necessary to eliminate this shock altogether shows that it is almost unattainable, but in practice the "kick" can be kept within reasonable limits without great difficulty. At DTMB, it is found sufficient to keep the dewpoint below -15°F and the air very clean so that very few condensation nuclei exist. In some higher-speed tunnels,



Model in 18- by 18-inch wind tunnel

such as the one at the Naval Ordnance Laboratory, White Oak, Maryland, this problem is much more serious and only very high initial temperatures prevent the air itself from condensing.



Schlieren photograph of Model

The air intake and filter-dryer is, therefore, an important component of the system. Housed in the basement of the building, it draws air from outside through a preliminary screening system which removes the heavy dirt, and then through a silica-gel filter which removes most of the water vapor and much of the fine dust. This foot-thick filter is 7 feet high and 48 feet long.

To provide enough air for normal operation of the 18-inch tunnel for a day, 8 tons of silica-gel are required. Fortunately the material can be used over and over. It is regenerated during the night by a system which heats it above 225° F, expells the moisture-laden air, then seals the intake and circulates cool air through the gel. Since this operation is entirely automatic, the equipment is ready for use each morning with a minimum of routine preparation.

In contrast to huge subsonic wind-tunnels, which are frequently large enough to take a full-size airplane, the chambers of supersonic pipes seem insignificantly small. And testing with small-fraction scale models, for just a few seconds at a time, may appear to lack the realism needed in designing aircraft. But so much has been learned about scaling, and about ways of recording and computing, that model testing has become as practical for aircraft as it has long since proven for ships.

Improvement on Life Preservers

Among the efforts of the Navy to improve survival equipment, has been some productive research and development on life preservers. The inflatable belt-type equipment used during World War II could be worn with convenience on duty, but offered no head support for an unconscious man in the water.

A British Admiralty-type CO_2 capsule inflated life preserver has been modified and adopted as standard for U. S. Navy Shipboard use. Carried in the small of the wearer's back, the life preserver as soon as it is inflated, will automatically turn the survivor on his back and keep his head well out of the water.

The Navy's Most Prevalent Disease

Commander William E. Ludwick, USN

Head, Dental Branch, ONR

In a country that relies on a relatively small standing military force for its security, the "weapons system" must be tops. A weapons system has been defined as equipment plus men—able-bodied men. In the Navy, the Bureau of Medicine and Surgery is responsible for keeping the uniformed men and women able-bodied, and for restoring to duty those who aren't. In considering this obligation it is apparent that all forms of health service contribute to maintaining an effective weapons system.

The most prevalent disease in the Navy is dental caries, more popularly known as tooth decay. Almost everybody is subject to dental caries during his lifetime; only about two percent of our population can honestly claim they never had a toothache. In some instances tooth destruction starts as early as three years of age and reaches its peak during the late teens. It tapers off in the twenties, but may continue slowly for the remainder of one's life. In general, it may be said that people are most susceptible to caries during the adolescent years.

Prior to World War II, men entering the Service had to meet certain oral standards. The number rejected in the early drafts because they did not have 18 vital teeth was so great that practically all oral standards had to be abolished later on in order to meet manpower requirements. We have had to adopt the philosophy that if a man can eat he can fight.

In the past it has been stated on numerous occasions by authorities of military dentistry and medicine that the condition of oral tissues and structures contributes immeasurably to the health of the individual. The condition of health is usually described in broad terms, such as "good," "fair," or "poor"—dependent mainly on the number or severity of bodily disorders. Type or types of disorders leading to this designation are not necessarily considered. Furthermore, in all such descriptions the mouth and its diseases are almost always neglected. This may be largely due to the fact that oral disorders and their treatment are a highly developed specialty. A person who has numerous dental cavities filled during a year's time is rarely thought to be in "poor health." Therefore, the possibility of a relationship between oral disease and other bodily dysfunction has never been seriously studied, until recently, that is. In 1954 a naval study was undertaken to ascertain if such a relationship exists.[1]

A group of 1080 Naval Aviation Cadets was taken as a sample. They were not examined personally but their cumulative 8-month medical

[1] J. H. Manhold and C. E. Izard, "Relationship of Dental Cavities to General Health" Science 120, 892 (1954)

histories were carefully studied. The name, serial number, complaint, diagnosis, treatment and disposition of the case were tabulated for each man. It was found that five or more dispensary visits were made by approximately 15 percent of the total population. Assuming frequency of medical complaints as a health index, these 178 subjects could be assumed to represent the "poorest" on a general health evaluation.

Then complete dental records, including X-rays, of this 15-percent criterion group, were collected where possible and DMF (decayed, missing, or filled teeth) ratings made from these records. The DMF rating represents a subject's total past and present dental caries experience; it is compiled by scoring one point for each surface of a tooth containing caries or a filling and three points for each missing tooth. The resultant mean DMF score of the criterion group was then compared with the mean Naval Aviation Cadet DMF rating formerly established.

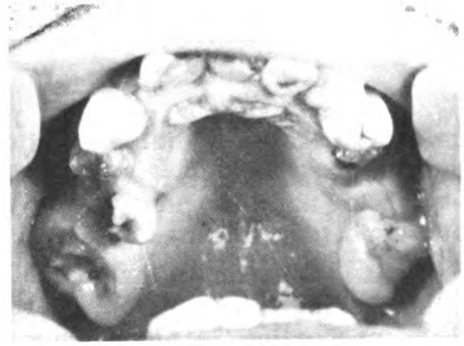
It was found that the group which was considered to be in the "poorest" health had a significantly higher DMF rate than those who were considered to be healthy. It should be noted that this significant difference was established on a population that can be considered above average in general health, having been screened by a rigorous physical examination prior to admission.

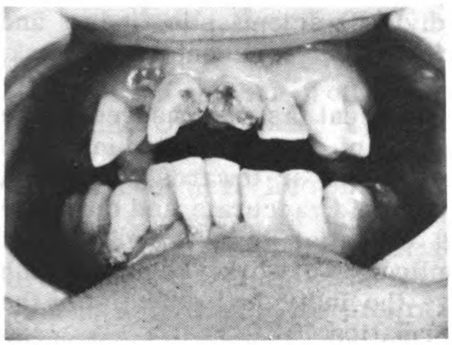
In recent years dentistry, as well as other branches of medical science, has postulated that certain chronic illnesses affect dental conditions, and conversely. This study, therefore, provides an interesting relevancy. It presents empirical evidence of a relationship between general health, as measured by frequency of medical complaints, and oral disorders measured by a decayed, missing and filled-teeth rating. This finding demonstrates that dental caries, as well as other somatic complaints, should be considered in any appraisal that attaches a general term, such as "good," "fair," or "poor," to a person's condition of health.

On several occasions during World War II and during fleet maneuvers, ships or submarines have had to be diverted from their assignment because a crew member required emergency dental treatment. In some instances men were transferred to other ships for treatment or for transportation to a dental activity. This has been costly and caused interruptions in the accomplishment of the assigned mission or task.

In an effort to promote better standards of oral health among its personnel, the Navy conducts a program of fundamental research in dentistry and related fields through the Office of Naval Research (Research Reviews, December, 1953). A major phase of this program is a study of the causes and means of prevention of dental caries. The structure and function of the various parts of the oral cavity, the composition of its fluids and their relation to general health, its ability to ward off disease through enzymic and other defense mechanisms, improvement of clinical and chemical stimulae are only a few of the many pathways dental research now follows.

Right: This is the mouth of one of the recruits who entered the Navy in 1950 at the Naval Training Center, Great Lakes, Illinois. It represents 9% of the group and is a typical condition.

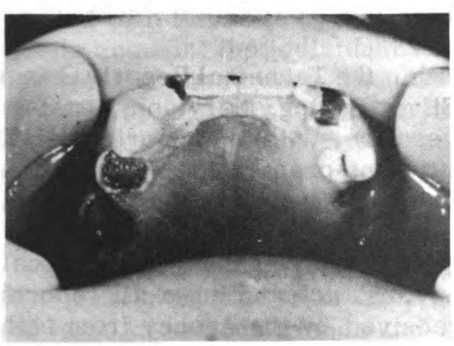


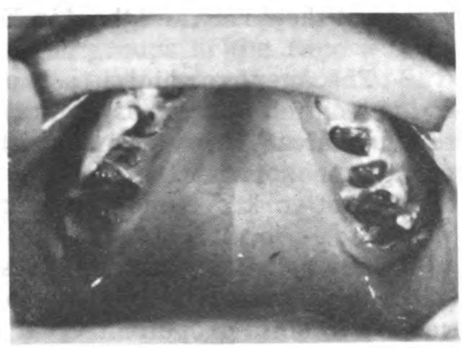


Left: This anterior view shows extensive caries in the upper front teeth. Not only is this a dental problem, but some patients who have these conditions may develop a mental complex relative to their appearance. They may even go so far as training themselves not to smile or laugh, in order to hide their teeth, and personality changes may follow.

Below Left: Shown are the maxillae of an 18 year old recruit. On the left side it is apparent that the two back teeth have been completely destroyed by caries, and on the right side one can see where teeth have been recently removed. To rehabilitate such a patient takes almost 3 months, and requires extensive surgical procedures followed by a period of healing and then the construction of dentures.

Below Right: This 17-year-old's teeth had been so completely destroyed by caries that the stumps had irritated the gingival tissue, so that in addition to the caries problem he had an acute gingivitis. By the next day this recruit had developed an acute Vincent's infection. With this condition he would be a potential health hazard to the entire crew.





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SPIA

P. K. Reily, Jr. and K. G. Britton

Applied Physics Laboratory, Johns Hopkins University

It is well known that scientific information has been generated at a staggering rate in recent years. The situation is complicated by the vast proportion of documents arising from Government-sponsored research and development programs, which for various reasons, among them security classification, do not get published in technical magazines. This increases the difficulty of an individual scientist in finding and reading, by his own efforts, current information pertinent to his work.

Most individual research and development tasks sponsored by the Government are part of a broader program of closely related tasks, in various laboratories, working in a given field or towards a common goal. Therefore in any program a very rapid, accurate and complete exchange of up-to-date information is essential to get the greatest progress and to prevent involuntary duplication of work. To accomplish this, a system must be set up to relieve the individual scientist of the burden of seeking out and selecting information.

A specialized information agency is one means of doing this. Such an agency is an integral, active part of the scientific field it serves, and maintains a close personal contact with the research groups in that field, performing many duties over and above that of a repository for technical information.

One such agency is the Solid Propellant Information Agency (SPIA) established in 1946 to facilitate the Services' program for development of better solid propellants for rockets, guns, guided missiles, and assist-take off devices for airplanes. SPIA was suggested by Dr. R. E. Gibson, now Director of the Johns Hopkins University Applied Physics Laboratory, and was established under a Navy Bureau of Ordnance contract. Support is shared by the Bureau of Ordnance, Bureau of Aeronautics, and Office of Naval Research of the Navy, and the Departments of the Army and the Air Force.

The Agency, which is a project within the Technical Reports Group of the Applied Physics Laboratory in Silver Spring, Maryland, consists of a technical research and editorial section, with a supporting staff engaged in secretarial functions, manuscript preparation, illustration and layout work, document distribution, report filing, and record keeping.

The technical staff consists of appropriately trained professional persons, primarily chemists, who review, abstract, and index all reports related to solid propellants that are received by the Agency from both American and foreign sources. These indexed abstracts are circulated at two-week intervals to a selected address list. At the end of each year, the abstracts are examined and the progress summarized in permanent abstracts, indexed, bound as a permanent volume and circulated. Bound volumes of abstracts are now available covering American solid propellant work through 1953 and foreign work for 1948 through 1953.

In addition to the abstracts the Solid Propellant Information Agency publishes and keeps current three manuals in loose-leaf form: The first of these is a compilation of design and performance data on solid propellant rocket motors. The second is a collection of information on the composition, physical and chemical properties, and ballistic evaluation of experimental and service-accepted propellant compositions. The third contains data on the physical and chemical properties, methods of preparation, and analyses of solid-propellant ingredients and lists their present and potential availability.

Because of its central and impartial nature, SPIA is in a position to perform a number of other important functions in the solid-propellant program. One of these is the preparation and publication of the "Joint Army-Navy-Air Force Mailing List for the Distribution of Solid Propellant Technical Information," which lists activities authorized to receive classified solid-propellant information and establishes the authority for direct interchange of such information among the addressees. This list provides the Government agencies sponsoring the various activities in the program with a sensitive control of information exchange.

SPIA also has been given the responsibility for coordinating the annual meetings of the Joint Army-Navy-Air Force Solid Propellant Group. The papers to be presented at these meetings are edited, published, and circulated by the Agency in advance, in order to establish a firm ground for discussion at the meetings. The coordination of these meetings also entails such clerical duties as establishing transportation schedules, arranging auditorium facilities, planning plant trips, organizing informal gatherings, and reserving hotel rooms. Members of SPIA also act as technical secretaries to such groups as the JANAF Panels on Analytical Chemistry, Physical Properties, and Static Testing.

The performance of these many functions of the Agency requires frequent visits by members of the technical staff to organizations connected with the solid-propellant program throughout the country. These visits acquaint the individual scientists and groups in the field with the services of the Agency, and, most important, give members of the SPIA staff an opportunity to familiarize themselves with the smallest details of the solid-propellant research and development program and to become acquainted with the participating organizations and individuals. This active scientific intimacy with the program has greatly increased the usefulness of SPIA, since it enables them to assist individuals in literature searches, to give newcomers in the field an incisive indoctrination into nearly all phases of the program, and to recognize new information of value to various groups and channel it to them.

It can be seen that a specialized information agency, with its many active functions, is not a duplication of more general information and document centers, such as the Armed Services Information Agency

(ASTIA), but rather consists of a group of specialized scientists, attached to a program, whose energies are concentrated upon getting the right information to the right place at the right time. Specialized agencies such as SPIA have helped meet the challenge of making effective use of rapidly accumulating knowledge. There is gratifying evidence that they have performed a valuable service to the scientific world and that they will continue to do so in the future.

As science has advanced, it has accepted the obligation to detach many of its members to teach its principles. Science must now meet a new obligation, to detach others of its members to help make its accomplishments bear fruit.

Corrosion of Metals at High Temperatures

The problem of metal corrosion--how fast and how soon to expect failure--has gained new importance because heat exchangers used in nuclear submarine propulsion rely upon an aqueous system and use stainless steel under conditions that other, less resistant, metals might corrode to quick failure. Because stainless steel makes use of strategic materials, a problem was initiated at NRL to investigate other metals that might resist corrosion at temperatures as high as 600°F and pressures as high as 2000 psi.

To cope with this problem, NRL investigators first had to devise a means for measuring accurately the rate of corrosion of metals in contact with an aqueous medium under the conditions set up as to heat and pressure. This was done by the development of apparatus which makes use of a well-known scientific fact--namely, that the hydrogen which results from the corrosion of metal will, at high temperature, diffuse through the walls of the metal at a comparatively rapid rate.

Two versions of the apparatus have been built. One measures the diffusion of the hydrogen (corresponds to rate of corrosion) through the metal when the aqueous media in contact with the metal is static. The other does the same job for a dynamic system in which the rate of flow can be set; actually at NRL some investigation was done at a rate of flow that was 1 foot per second, and at another rate that was 30 feet per second. Work has gone ahead to ascertain what the corrosion effects might be on various likely metals if selected chemical constituents were put into the aqueous medium. It is already clear that mild steels, after an initial period of relatively rapid corrosion, acquire a protective film which reduces their corrosion rate. Thus they give promise as a possible substitute for stainless steel which would not only circumvent the need for a strategic material, but would afford the added advantage of relatively low cost.

SEAC Determines Low Bidders

A. J. Hoffman

. . .of ONR's Logistics Branch, is on loan from the
National Bureau of Standards

A high-speed electronic computer is now being used for determining low bidders, quickly and accurately, on military contracts at the National Bureau of Standards. Now being applied by H. Bremer, W. Hall, L. Joel, M. Paulsen and others in response to needs of purchasing agencies of the Department of Defense, and through liaison established by the ONR Logistics Project at the George Washington University, the NBS methods provide an exact basis for awarding contracts among competing bidders at least cost to the Government. Contracts for several million dollars worth of soap, paper, insignia, and other products have been let on the basis of computations carried out by SEAC (Standards Eastern Automatic Computer), with consequent savings in time and costs.

The analyses required in awarding Government contracts are usually extremely complex. Fortunately all procurements have certain features in common, although each may present its own special difficulties. For example, in most cases the Government buys simultaneously for several depots. The different freight costs from the factories to the depots enter significantly into the cost of the item purchased; hence, the manufacturer's bid prices must be modified to indicate the true cost including transportation. Also, each manufacturer generally states a maximum quantity he is willing to produce, and frequently he states a maximum acceptable quantity as well. He may quote several prices, depending on the quantity awarded. In fact, he may impose any of a wide variety of restrictions and conditions on his bid. The problem faced by the awarding agency is to determine the quantity each manufacturer should make and the depots to which he should ship his production. Approximate answers, no matter how close to true least-cost-solution, are unsatisfactory. The law requires that the awards be made on an exact basis.

In the past the search for accurate answers has required lengthy, painstaking analyses by trained personnel. The computation methods used by NBS not only provide an exact answer in a short time but, if required, can determine shipping schedules for each manufacturer. For example, the right sizes of clothing can be scheduled to reach each depot in the required amounts each month.

The high-speed computation methods now being used in determining low bidders have resulted from a continuing program of research which NBS is conducting for the Air Force on the mathematical theory of linear programming. Support for this work was also contributed by ONR, which has actively promoted linear programming in both its theoretical and applied aspects. This new mathematical field, in combination with electronic computation, provides a speed and accuracy previously unobtainable in the solution of certain military supply and logistic problems.

The first step in setting up a least-cost problem is to interpret mathematically the various conditions imposed by the Government and the bidders as problems in linear programming. On the basis of this analysis, one of several linear-programming computation procedures previously coded for SEAC is applied to data of the specific problem. After the coded information has been placed in SEAC, the computer usually obtains the answers in about two hours. Data preparation and computation are carefully checked at each stage.

The computation procedures are based on a method pioneered by G. B. Dantzig of the RAND Corporation (formerly with the Air Force) for solving linear programs. First the computer chooses an award which satisfies the various restrictions but is not necessarily the least costly. The machine then searches for a cheaper allocation among the bids submitted. If there is none, the answers corresponding to the award first selected are printed on the output teletype. If, on the other hand, a cheaper allocation has been found, the computer substitutes it for original award and begins again to search for a cheaper one. The process continues until no cheaper award can be found. The number of searches that is necessary varies with each problem, but it is approximately the sum of the number of bids and the number of depots. Sometimes, if the bidders' conditions are rather complicated, the problem must be run several times before the solution can be obtained.

Appointment to Head of Biology Department, Johns Hopkins University

Dr. William David McElroy of the ONR Advisory Panel for Microbiology, has recently been appointed head of the Biology Department of Johns Hopkins University. Previous to this appointment Dr. McElroy had been an Associate Professor of Biology there since 1948 and also Director of the McCollum-Pratt Institute. At present he is principal investigator of an ONR Biology Branch sponsored project to study the mechanisms by which coenzymes are synthesized, a process of fundamental importance throughout the animal kingdom.

Arctic Research Laboratory

Figure 1 - ARL is the H-shaped building in the center.

In 1946, the necessity for detailed information on the Arctic prompted Vice Admiral Harold G. Bowen, Chief of Naval Research, to propose a laboratory which would be located in the area under study and provided with proper facilities and equipment to conduct effective investigations on arctic environments. The selection of Point Barrow in Alaska took advantage of an existing situation as the Navy had for some time been conducting explorations for petroleum from a base established at this seaport on the Arctic Ocean. Furthermore, the settlement of Navy people was flanked on three sides by 35,000 square miles of frozen tundra land controlled by the Navy as Petroleum Reserve No. 4.

Early in 1947 arrangements were completed for the building of a laboratory within the isolated community, and in August of that year, Dr. Lawrence Irving took over as the first director of the laboratory. He arrived with six other scientists—four from Swarthmore College, two from Cornell University. From this modest beginning, the Arctic Research Laboratory (Figure 1) has become a focal point for many a piece of research extending over many fields of science. By the end of 1954 more than 200 scientists from 30 universities had trekked their way to this facility provided by the Navy for study of the frozen North. In addition some ten organizations other than universities had been on hand with representatives or in some other way enlisted the services of the Laboratory.

In 1953 the logistics support was transferred to the staff of the Laboratory as active petroleum explorations were discontinued in Navy Petroleum Reserve No. 4. Then, early in 1955, the Air Force came to

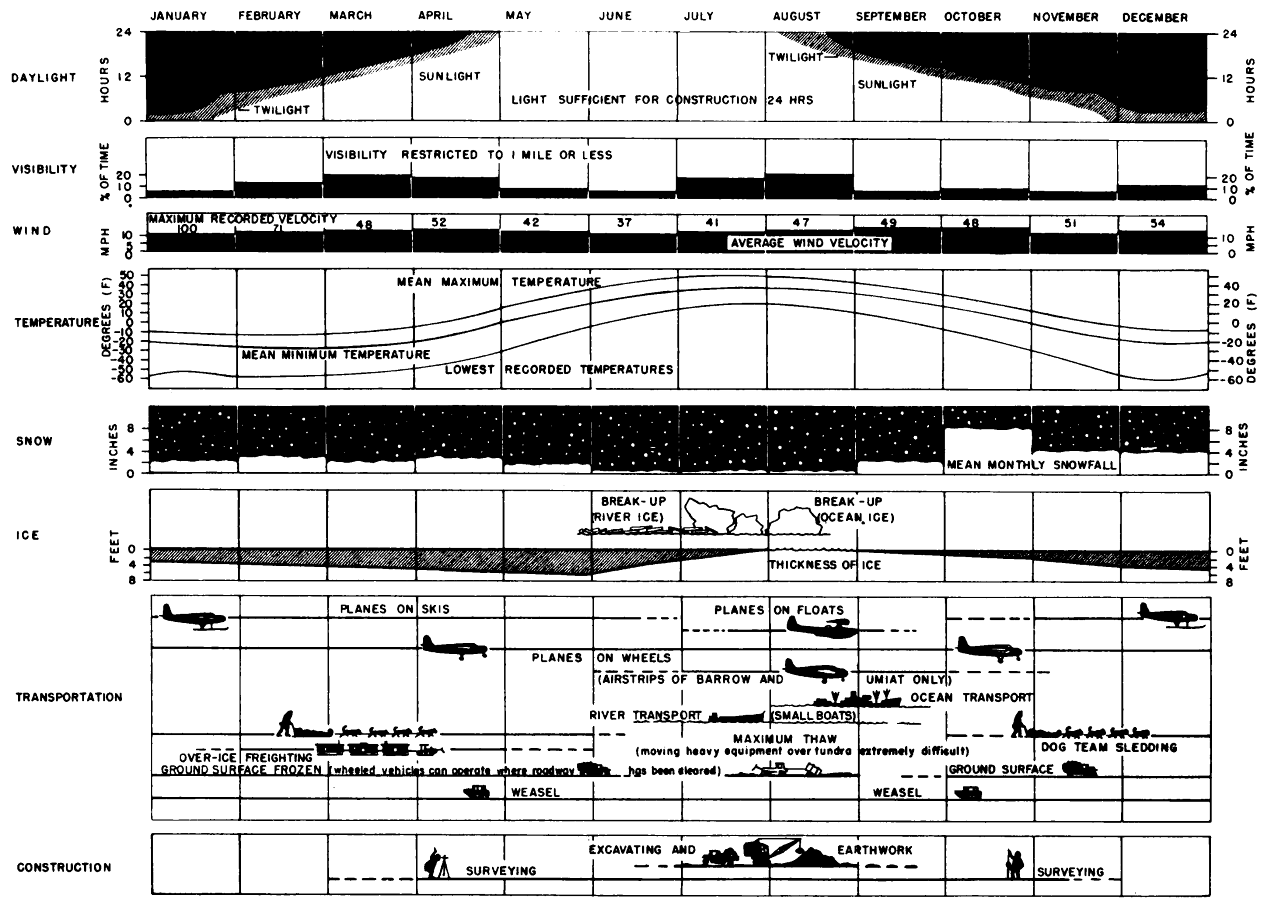


Figure 2 - Climate vs operations on North Coast of Alaska
(adapted from Arctic Contractor Drawing No. 58)

Point Barrow and assumed the responsibility of base administration (Research Reviews, January 1955).

The site of the laboratory on the shore of the Arctic Ocean, backed by a broad tundra plain, offers opportunity for research on many uniquely arctic problems such as arctic environmental factors as related to man's work and survival, auroral phenomena and their effects on radio propagation and geomagnetism, periglacial geomorphology, permafrost, sea ice, arctic oceanography, arctic meteorology, and ecology and physiology of arctic life.

The coastal plain is low, flat, and poorly drained. Numerous northeast-oriented elliptical lakes and polygonal mounds dominate the landscape and make travel difficult in summer. The material of the coastal plain is gravel silt or peaty muck perennially frozen to depths up to 1300 feet. During the summer a layer of from one to two feet of this so-called permafrost thaws, producing wet, soggy ground on all but the higher mounds.

Local summer travel is principally by the M29c amphibious vehicle (weasel), or by boat. In winter, the caterpillar tractor as well as the weasel and the dog sledge are used for surface transportation. The airplane on floats or on ski-wheel combination provides the best year-round transportation for distant trips.

The climate at Point Barrow is truly arctic. There is perpetual sunlight for about three months of the summer, and a corresponding winter period when the sun does not appear above the horizon. In the mid-day hours of winter there is faint or bright twilight depending upon the angular distance of the sun beneath the horizon, and the light of the moon and stars and the play of the aurora borealis at times relieve the darkness.

Temperatures at this far northern location remain below the freezing point for most of the year, the daily maximum reaching 32° F or higher for only about 110 days during the average year. The daily minimum remains below freezing for an average of 323 days of the year. The coldest period at Point Barrow is usually February which averages -17.9° F, and in February 1924 an extreme low of -56° F was recorded. The warmest month, July, averages 39.7° F; an all time extreme high of 78° F was recorded in July 1927. Normally the summer temperatures range from the middle twenties to the middle forties and the winter temperatures from 10° to -30° F.

Precipitation is scant but certainly cannot be ignored. Light snow flurries are possible during all months of the year, and summer rains at times curtail field work. The greatest amount of precipitation occurs in summer, usually in the form of a drizzly rain. October has recorded the most snowfall, averaging 6.7 inches as a monthly total. Because of wind and the light nature of the rain and snow, it is likely that the precipitation is much greater than the amount recorded by precipitation gages.

The Arctic Ocean is largely frozen over during most of the year. Ice break-up generally takes place in July and open water along the shore

(shore leads) is usual until October. Fog and low clouds are frequent in summer, with June and July averaging ten days each of heavy fog and only two days clear. The weather elements as related to field operations are shown graphically in Figure 2.

FACILITIES

The Arctic Research Laboratory provides modern well-equipped laboratory facilities, a base of operation for field investigations, and logistic support for scientists engaged in research on arctic problems. Normal logistic support consists of air transportation from the scientist's home station to Point Barrow and return, lodging, meals, cold-weather clothing, laboratory space and equipment (with some restriction as to amount and availability), such transportation facilities (boat, weasel, jeep, or bush plane) as conditions and equipment permit, and the use of camping equipment and such field instruments as may be available.

The main laboratory building is an H-shaped structure consisting of two 40- by 100-foot arch-rib quonset-type buildings connected by a 20- by 80-foot quonset. The buildings are heated by warm-air furnaces burning natural gas. A standby reserve of fuel oil is available in the event of failure of the gas well or distributing system. On the ground floor of this structure are 17 laboratories each fitted with a sink with hot and cold running water, 110- and 220-volt ac power supply, gas, and compressed air. The walls separating some of the laboratories are so constructed that two rooms may be combined into one without involving major alterations. On the second floor of one of the large wings are living quarters for 36 men and on the second floor of the other wing are located the Science Director's office, the storage and stock room, and a working museum and library. The library contains a growing collection of standard references in the sciences and on arctic lore and exploration. Space has been made available for collections and reports from investigations. The library is used for occasional seminars and lectures and has standard film-projection facilities.

A darkroom fitted with normal darkroom chemicals and equipment is available but investigators must supply their own film, printing paper, and cameras.

A shop housed in the connecting quonset is equipped with a machine lathe, milling machine, drill presses, and all necessary wood-working apparatus to meet ordinary needs and to do most types of repair work for the Laboratory. Another small quonset (20 by 48 feet) with outside and inside cages serves as a building for experimental animals.

Included in the specialized equipment available at the Laboratory are the following: a 625-cu ft cold box for storage at -30°F, a 125-cu ft box for storage at -10°F, two deep-freeze units and three standard refrigerators, a water-distillation apparatus, an International centrifuge (type SB, size 2), a Beckman Quartz Spectrophotometer, a Coleman Junior Spectrophotometer, angle centrifuges, balances, pumps, respirometers, ovens, research and dissecting microscopes, calculators, and water baths.

A unique feature of ARL—with respect to arctic installations—is its dependable year-round water supply which is derived from a fresh-water lake and serves the research and living quarters.

The Laboratory has on hand all the common types of glassware, chemicals, and laboratory expendables. Only such equipment and supplies as can be used in several different fields of research are regularly stockpiled or supplied by ARL. Special apparatus or supplies needed for many projects must be furnished by the investigator, by his own institution, or purchased by funds available under his contract. Such supplies and gear should be shipped to ARL only after consulting with the Science Director of the Laboratory (SDARL).

Three miles south of the main laboratory building is a magnetic observatory where specialized research on problems related to fluctuations of the earth's magnetic field are studied. During the International Geophysical year 1957-58, the laboratory will be one of the stations engaged in a concerted program of observation on geomagnetism, aurora and airglow. The site is a factor in the coordinated work to be done as Point Barrow is within the band of greatest magnetic disturbance and auroral activity. Attention will also be given to problems of radio communication, as disruptions due to magnetic storms, ionospheric storms, and the aurora are felt mostly in the arctic and sub-arctic regions.

Four small quonsets provide eight apartments—consisting of living room, bedroom, and bath—for married couples (Figure 1). Dormitory space is also available, and the current operating arrangement with the Air Force permits 60 scientists to be provided logistic support at ARL. This support, which is furnished through the Air Force and its contractor operating the base at Point Barrow, includes meals for all ARL personnel at the contractor's mess, maintenance and repair of vehicles and boats, heating and repair of buildings, and other housekeeping services. The Air Force contractor will also provide limited medical and first-aid facilities, and a government hospital in the village is well equipped and has a doctor and nurses in residence.

The Laboratory owns and operates a 36-foot motor launch with light dredge and fathometer and four converted landing craft (LCM) equipped with trawls, dredges, and fisheries winch with 3600 feet of steel cable. One LCM is equipped with a heavy-duty winch and line capable of dredging to 15,000 feet. These craft provide facilities for limited oceanographic research. Several skiffs and boats are available for work along the coast or on inland lakes and rivers.

Weasels, jeeps, and amphibious tractors (LVT) provide local overland transportation, and bush planes are chartered for longer trips. A large variety of field gear is available including field meteorological and biological equipment, traps, cages, camping equipment, tents, and specialized arctic clothing. Requests for these facilities must be included in a scientist's proposal, as costs and schedules must be adjusted to available equipment and funds. It is usually necessary for research teams to cooperate on the use of boats and other transportation facilities in order to utilize most effectively the available equipment and operating funds.

Eskimo guide service is made available, and is required on all distant trips, and when an investigator would otherwise be alone in the field. The Eskimo is a willing worker and some are skillful carpenters, mechanics, or machine operators.

The University of Alaska operates and maintains the Laboratory under a contract with the Office of Naval Research. The Science Director (SDARL) and all permanent operational staff members are employees of the University of Alaska. When the arrangements have been completed to conduct scientific work at ARL, and the personnel assigned to do the work trek northward, the first stop is Fairbanks, Alaska and the University of Alaska. There he will be squared away on his needs, and particularly in the supply of proper arctic clothing. The University takes care of transportation arrangements to take personnel to Point Barrow.

Scientific planning for the research to be performed at ARL is the responsibility of the Geography Branch of the Office of Naval Research. Guidance in the formulating of a program of research, in the recruiting of able scientists, and in the review of research proposals is provided by the Arctic Research Laboratory Advisory Group (ARLAG) of the Arctic Institute of North America (AINA). This group consists of representatives from university, government, and private agencies who have had experience in conducting research or operations in the Arctic and who represent various scientific disciplines. The Geography Branch is also advised and assisted by the ONR Committee on Arctic Research, a group consisting of representatives from ONR Branches having an interest in the Arctic.

Other pictures of ARL are on the inside back cover.

New Branch at ONR

The increasing interest of the Office of Naval Research in human engineering has prompted an organizational change which established the Engineering Psychology Branch. Previously there had been a Human Engineering Section--the activity has now graduated to branch status. As a consequence, the Psychological Sciences Division has four branches; the others are Personnel and Training, Group Psychology, and Physiology Psychology.

A scientist from NRL, Dr. Franklin V. Taylor, has been drafted to head the new branch. He is scheduled to spend half-time at ONR until a permanent director is found for the new program. The other half of his time is spent at NRL where he carries on with his regular duties as head of the branch there which has the same name as the new one at ONR. The assistant to Dr. Taylor at ONR is LT Albert E. Hickey who has been associated with the previous Human Engineering Section for a year and a half, and contributes his intimate knowledge of past activities to the work of the new branch.

Research Notes

Drone Helicopter

A small remote-control helicopter (see cover) has been successfully built and flown by the Kaman Aircraft Corporation of Bloomfield, Connecticut. It is now being evaluated as a research and development prototype.

Designed by Kaman under an ONR contract, the radio-controlled drone is basically a Kaman HTK-1 helicopter which has been modified so that it can be flown by a pilot seated in a ground control station. The project has been under way at Kaman for eighteen months and the "drone" has been flying for nine months, during which time about ninety hours of remote control operation, including take-offs and landings, backward, sideward, forward and hovering flight, has been accomplished.

In flying the remote-control helicopter, a pilot is seated in a ground station which has controls similar to those in the helicopter. Movements of the ground station controls are transmitted by radio to the controls in the "drone" helicopter and the "drone" thus responds to the "commands" of the pilot seated on the ground. Although this system is somewhat similar to the remote-control of fixed-wing aircraft, the problems that had to be overcome in the remote-control helicopter were far more complex by virtue of the helicopter's ability to rise and descend vertically, stand still in mid-air, and fly forward, backward and sideward, slowly or rapidly. In addition to developing the remote-control system, it was necessary for Kaman engineers to design and build a suitable automatic pilot and miniature gear boxes small enough to be used with the system.

Since the prototype is the only one of its kind, all flights made thus far have been with a safety pilot aboard, ready to take over in case of emergency. All flights to date have been limited to the visual range of the pilot operating the aircraft from the ground station.

Flying Radar Laboratory

The Naval Research Laboratory has instrumented an R5D aircraft (Douglas DC-4) as an airborne radar and radio wave propagation laboratory. Four radar sets, in the frequency range from 1,000 to 10,000 megacycles, are mounted in nacelles beneath the wing. A 15-foot mast, mounted approximately midway along the fuselage, may be raised and lowered in flight and houses instruments for making meteorological observations. In addition to four radar consoles, the cabin of the plane contains the necessary control equipment, including eight two-gun cathode-ray oscilloscopes, with cameras for recording the data obtained during experimental flights.

The installation was designed to be as versatile as possible for investigation of a wide variety of problems in two general fields of interest to the radio engineer, those of radar target properties and of radio wave propagation. In the first field, it may be used to determine the reflecting or back-scattering properties either of individual targets or of area-extensive targets such as ground, sea, or precipitation. In the radio wave propagation field, it may be used as one terminal of a one-way transmission link, such as in investigation of radio ducts and atmospheric scattering. The meteorological instruments will provide supplementary data, including wet and dry bulb temperatures, refractive index of the air, rain drop size and distribution, electric fields, total water content, and total pressures of the air.

The four wing-mounted nacelles carry not only the radar antennas (4-foot parabolas) but the transmitters and the "front end" portions of the receivers as well. The antennas all point together and are gyro-stabilized on three axes—to hold steady in spite of pitch, roll, and yaw. The common control for the four antenna servomechanisms is in the cabin, and may be adjusted to a prearranged schedule. Or control may be synchronized with a telescope which will be fitted near the nose of the plane; the telescope is nearing completion in the NRL shops. The antennas and transmitter-receiver systems allow transmission of vertical, horizontal, or circular polarization, with simultaneous reception of the transmitted polarization and its orthogonal component. For example, when transmitting right-hand circular polarization, both right-hand and left-hand circular polarized components are received in separate channels. The receiver outputs are presented on oscilloscopes or plan-position indicators and are usually recorded photographically.

The data-recording cameras operate from a camera control which allows a known number of pulses to be recorded at known intervals of

time. Data such as altitude, speed, and polarization are presented on synchros, lights, and meters which are photographed by a frame-by-frame camera. All photographic records are closely correlated through time.

The aircraft was turned over to NRL January 7, 1955, after completing successfully all phases of its flight test program. Since that time, it has been based at Patuxent Naval Air Station and the radar systems have been undergoing adjustment and calibration. Although it appears that certain liberties have been taken aerodynamically, the aircraft will still fly. In fact, its flight characteristics, with the exception of increased drag and consequent loss of speed, have not been hampered by the installation.

At the present time two radar systems are in operation and it is expected that within a month or so all systems will be ready for use. First use of the plane for sea and ground clutter measurements is now scheduled for May or June.

Ions are Forever Blowing Bubbles

Nuclear physicists under ONR contract at the University of Chicago are using a new instrument called a "bubble chamber" to record the tracks of ionized nuclear particles. Ordinarily, the "cloud chamber" of C.T.R. Wilson is used for this purpose; in the cloud chamber, a saturated vapor is made supersaturated by a sudden expansion, and an ion passing through this region leaves a visible track of condensed "fog" droplets.

In the new instrument, the supersaturated vapor is replaced by a superheated liquid, and the ion track is composed of minute bubbles. Successful operation has been obtained with liquid hydrogen, nitrogen, and pentane, and future development will doubtless add other liquids to the list. Meanwhile, the tracks obtained in the present chamber are fine enough to allow precise measurement of scattering angles, and, owing to the high density of the liquids, more complete histories of nuclear events can be recorded than if a cloud chamber were used.

The venerable cloud chamber, nonetheless, will be a familiar sight around laboratories for some time to come, since the new instrument is less portable, more difficult to operate, and not suited for use as a cosmic-ray tracker.

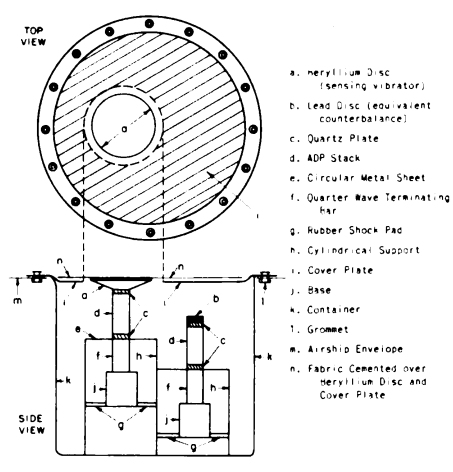
Individual Versus Group Judgment

Research conducted under ONR contract has shown that a member of a group attempting to judge a problem will, upon finding himself a minority of one, often render a judgment which conforms to the expressed majority opinion. He may do this, moreover, in the face of definite evidence that the majority is incorrect. The most recent studies of this phenomenon show that the tendency to conform is even greater if a substantial reward is offered for correct group judgment.

Airship Ice Detector

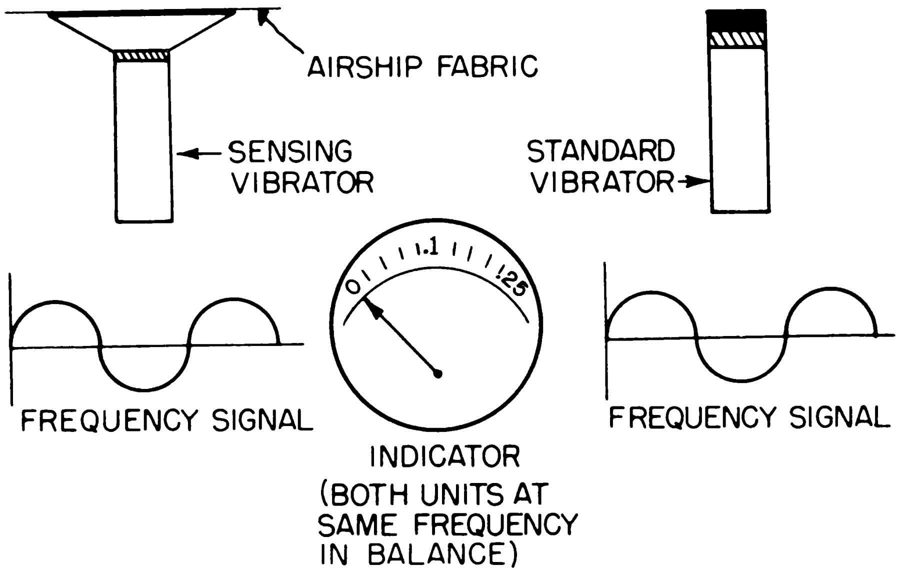
Considerable research and developmental work has been done on devising means to detect and eliminate the accumulation of ice on high-speed aircraft. Until recently, however, practically nothing has been done toward alleviating the icing problem for lighter-than-air craft. Increased interest in the possible use of airships for round-the-clock operations on Airborne Early Warning and Anti-Submarine missions created a demand for an instrument that would serve as a research tool to detect and measure the accumulation of ice on an airship envelope. Although the chief emphasis in this article is placed on an airship ice-measuring instrument, it is felt that with minor modifications the instrument and techniques employed could be applied to fixed-wing aircraft as well.

The Clevite ice accretion instrument described herein was developed primarily to support the Airship Icing Project which ONR recently assigned to the Naval Air Development Unit, NAS South Weymouth, Massachusetts (Research Reviews, January 1955). Flights under all types of icing conditions including freezing rain will be made by an extensively instrumented airship to help determine the all-weather capabilities of lighter-than-air craft. Whenever accumulation of ice or snow is suspected, the primary tactical maneuver employed by all airship pilots is to take "immediate evasive action" by change of course or altitude. Consequently, practically no information is available on where, or how much, ice accumulates on an airship in flight, nor has any airship ever been known to have been forced down due to ice or snow. It is anticipated that the Clevite Ice Accretion Indicator, which has been installed on the ZPG icing airship, will furnish to the pilot a means of detecting the accumulation of ice rapidly and also indicate to him the rate of ice accretion. This should enable him to probe icing areas more effectively and safely. The system now consists of one indicator in the control car and three sensing units mounted in the top of the envelope—one in the forward section, one in center, and one in the after section. Prior to installation, all three sensing units and the indicator were calibrated and checked in the low-temperature test chamber at the National Advisory Committee for Aeronautics Lewis Flight Propulsion Laboratory, Cleveland, Ohio.

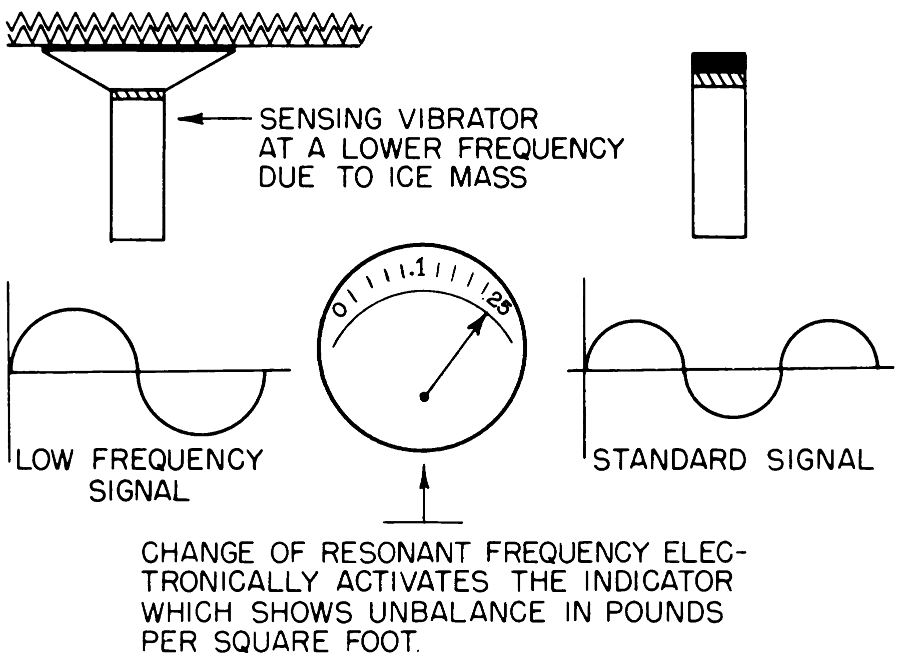


Ice detector assembly

Basically, this system incorporates two small solid crystal stacks which are electrically vibrated and connected to a frequency detector and an indicating instrument for reading the accumulation of ice in pounds per square foot. One of the crystal stacks is the sensing element which is installed with its container at the surface area in which the detection and rate of accumulation of ice is desired. Installation is in such a manner that the top section of the sensing element is mounted flush with the aircraft surface area with airship fabric cemented onto the top beryllium disc and over the cover plate as shown in the inset. The mass (ice, snow, liquid, etc.) that accumulates directly on top of the beryllium stack (approx. 2 inches in diam.), is measured quantitatively and the unbalance in frequency is shown on the indicator as illustrated below.



No-ice Condition



Sensing Head in Iced Condition

Meeting at the U.S. Naval School of Aviation Medicine

A symposium was held in March on problems of physiological-psychology at Pensacola where the U.S. Naval School of Aviation Medicine acted as host to visiting ONR contract scientists from all over the country. Under the sponsorship of the Physiological-Psychology Branch of the Office of Naval Research, these scientists exchanged information on their work in sensory and perceptual processes.

Representation at the meeting included not only specialists working on Navy problems, but a number of scientists from outside the Navy and identified with universities and such organizations as the Bell Telephone Laboratories, the Rockefeller Institute for Medical Research, and the Central Institute for the Deaf, St. Louis.

The papers were presented and discussions generated on subjects that had been carefully scheduled to emphasize the functional or operational relationships between the stimulus and the response. This sequential type of presentation provided the scientists with an opportunity to determine the place of their research in a broad physiological-psychology program. Papers in the field of vision were given in sequence starting with the nature of the stimulus, continued through the physical, bio-chemical, chemo-electrical, and neurological processes resulting in perception and response. This procedure was followed on other presentations which extended over a two-day period.

Among the papers presented were a series of three which approached color vision from the standpoint of the a bio-chemist, a psychologist, and a scientist who resorted to algebraic methods. Because these three all aptly supplement each other, and because of the interest generated, such a coordinated presentation is regarded as a promising pattern for future meetings. A model of the human ear was used effectively in a talk on auditory perception and vibration patterns. Among the more unusual methods of human communication is the one that resorts to the skin's ability to receive and discriminate vibratory signals. Potentialities of such cutaneous reception were brought out in a paper which also dealt with training possibilities of "hearing through the skin" (see Research Reviews, October 1954). "The Organization of Neural Activity in the Eye" presented new information in the field of vision, and a report on unsuspected properties of the dendrite nerve cells (the forgotten fiber of nerve physiology) was given in "Cortical Networks."

All of the papers presented new material in accordance with the request that accompanied the announcement of the symposium. None had been read or published previously. The value of the symposium was emphasized by the group action, the development of ideas, and the manner in which those in attendance served as a sounding board for some educated guessing. Furthermore, it strengthened the identification of these people with the Navy's program, and tends to bring them into a team working on physiological-psychology problems. The planning and arrangements of the symposium were under the direction of Dr. Richard Trumbull, Head, Physiological-Psychology Branch, ONR.

On the Naval Research Reserve

The Four Captains of NRRC 9-3

Four-striper Professors Louttit, Miller, Sawyer, and Davis

At Ann Harbor, where the University of Michigan has such a large and varied interest in research, four educators on the university staff hold the rank of CAPT in Research Reserve Company 9-3. Ralph A. Sawyer is dean of the School of Graduate Studies; Chauncey M. Louttit, Chairman of the Department of Psychology; Charles M. Davis, Professor of Geography; and Freeman D. Miller, Associate Professor of Astronomy.

Dean Sawyer completed his undergraduate work at Dartmouth and later received a doctorate in physics from the University of Chicago where he worked under Dr. Robert A. Milliken. World War I brought first Navy service to Dean Sawyer; he was attached as an Ensign to the Naval Gun Factory as an inspector, and then engaged in research connected with optical fire control. More Navy duty came in World War II when Dean Sawyer with the rank of LCDR was put in charge of experimental laboratories at the Naval Proving Ground, Dahlgren, Va. Later in 1945 he went on a Navy Technical Mission to Germany, and then settled back to his civilian pursuits as an educator. But with the 1946 tests on the atomic bomb at Bikini, Dean Sawyer was called in as an assistant on technical aspects, and was the only civilian on Admiral Blandy's staff.

Dr. Louttit has a B.S. degree from Hobart College, and a Ph.D. from Yale University. The Navy called him in 1940 on an assignment with the U.S. Naval Medical School in Washington, D.C. Dr. Louttit then moved on to other jobs, and at the end of the war was commanding officer of the Service School Command, Naval Training Center, Bainbridge, Md.

The identification of Dr. Davis with the University of Michigan extends back to his undergraduate days. His three degrees, A.B., M.A., and Ph.D., all came from the university. After experience with the Army during World War I, the Navy claimed Dr. Davis in 1942 when as a LCDR he was assigned to duty at the Naval Air Station, Clinton, Okla. Here and later he was with the special Air Task Force, and was shifted into experimental aeronautical research in connection with the testing of radio-controlled aircraft. When the Research Reserve company was organized at the University of Michigan in 1949, Dr. Davis was the first commanding officer.

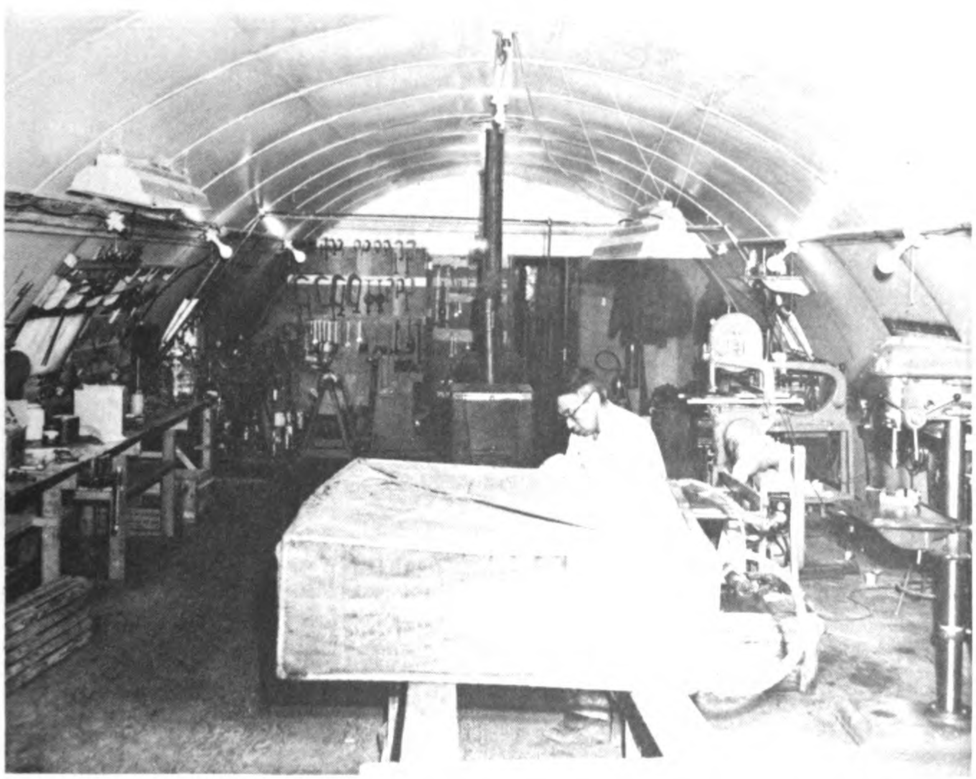
Dr. Miller received his B.S., M.A., and Ph.D. from Harvard where he was enrolled in the first NROTC class at the University. In 1940 he was called to active duty and had several sea-going jobs before he graduated to staff assignments with a Destroyer Squadron and with Commander Air Fleet, Quonset Point, R.I. Then he moved on to NROTC work at Rice Institute, Houston, Texas before returning to civilian life in January, 1946.

The Fort Walton Beach Company

The picture below, taken during the commissioning ceremony of NRRC 6-15 at Fort Walton Beach, Florida (Research Reviews, February 1955), could serve as a pictorial organization chart for the Naval Research Reserve program.

In the center CAPT Theodore Blanchard, Special Assistant to the Chief of Naval Research for the Research Reserves, is handing the commissioning order to the Company's Commanding Officer, CDR H. W. Hoyt. At the extreme left is LCDR James Bedsole, NRR Program Officer, Southeastern Area, and at the extreme right, LCDR C. A. Buist, Jr., Program Officer in ComSix. Behind these principals are the active members of the Company. Left to right, they are: LCDR J. A. Durrenberger, W. E. Taylor, SH3, LCDR C. E. Long, Jr., CDR R. C. Hoffman, LTJG R. M. Goldsmith, LCDR T. H. Dalehite, LT K. V. Woolsey, LTJG R. E. Greene, Jr., LCDR R. J. Billingsley, and CDR R. B. Coe.

One of the seventeen laboratories at ARL



The ARL shop. The shop foreman is assisted by skilled Eskimo helpers.
(See text - page 13)

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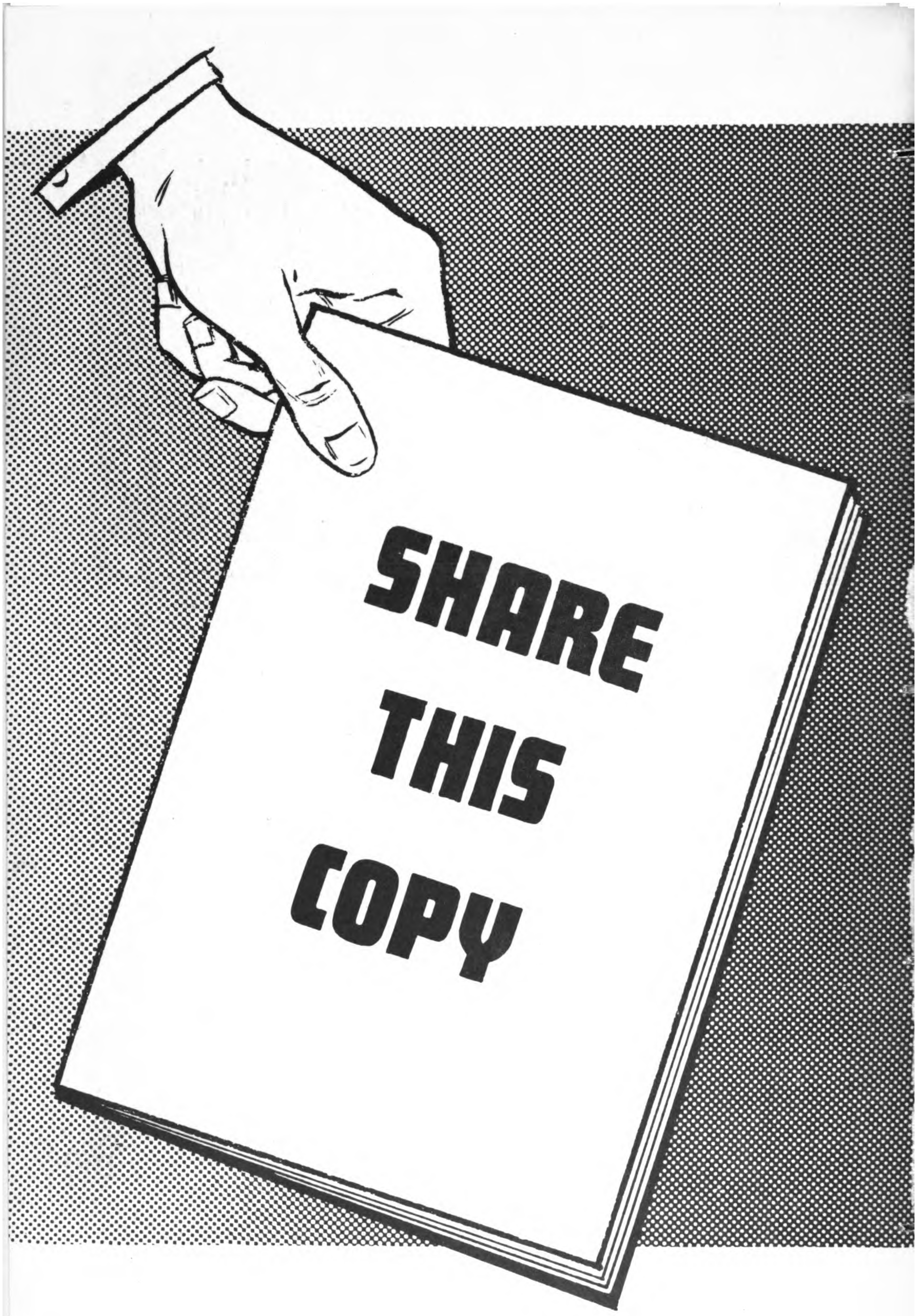
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