The Tech

Vol. LXV, No. 34 CAMBRIDGE, MASS., SATURDAY, NOVEMBER 10, 1945 PRICE TEN CENTS

VICTORY IN SCIENCE

War Secrets Are Given First Showing

Pres. Karl T. Compton Reviews Tech War Work In Corporation Report

Radar And Jet Propulsion Demonstrated; Navy Will Enact Rescue On Charles

Tells Of High Spots In Development Of New Instruments For War

The Massachusetts Institute of chnology was the scene of very ensive research and develop- nt work on many varied war jects. The most widely known these are, of course, radar and differential analyzer. In the owing paragraphs we shall pre- t brief surveys of some of the er known, but very important, jects carried on here.

ext to radar, the M.I.T. devel- nent most extensively used in ual combat was probably the per computing gunsight, which oduces the proper lead angle in g at moving targets, be they ks or airplanes or ducks. It is of a large number of devices loying gyroscopic principles ch were invented and built in Instrument Laboratory under direction of Prof. C. Stark er of the Aeronautical Engi- ing department. Some 80,000 e gunsights were installed on l vessels for direction of the firing anti-aircraft guns, and turned in a splendid record nst Jap aircraft, particularly kamikaze "suicide planes." The tute was helped in this work by ncial backing from the Sperry scope Company.

der Prof. Gordon S. Brown of Electrical Engineering depart- , a servomechanisms labora- was established and widely in developing automatic con- for the armed services. The atory staff developed mech-

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MASSACHUSETTS INSTITUTE OF TECHNOLOGY
OFFICE OF THE PRESIDENT

November 9, 1945

To the Open House guests:

Through the courtesy of *The Tech*, I want to take this opportunity to welcome you to the Institute in behalf of the Massachusetts War Finance Committee and the M. I. T. staff. The Army, the Navy, the Coast Guard, and the Office of Scientific Research and Development have cooperated in providing the equipment for these exhibits. Much of the materiel on display is open to public inspection for the first time and exemplifies some of the major contributions of scientists and engineers to maintain technical superiority over our enemies.

The Institute, by acting as host to our many thousands of visitors, is glad to contribute to the success of the Victory Loan Campaign.

(Signed) KARL T. COMPTON
President

Tech Division Of Industrial Cooperation Handles 400 War Research Contracts

One phase of the Institute's war activities which of necessity has been veiled in a heavy cloak of secrecy is the Division of Industrial Cooperation. This body was organized to handle all the war commitments accepted by the Institute, and in the past five years has engaged in 400 such contracts. Designed for the furtherance of the national war effort, 161 of these contracts were directly with the Army and Navy, or other governmental agencies, 89 with Dr. Vannevar Bush's Office of Scientific Research and Development, and 150 with large industrial concerns. Not included in the above total are 275 orders for wind tunnel work.

The Division is headed by Mr. Nathaniel McL. Sage, under whom 567 individuals were employed in the various war researches. Of this total, 85 were members of the instructing staff at the Institute, many of whom often carried teaching loads in addition to their D.I.C. responsibilities.

In 1942 the volume of business handled by the Division totaled

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Attendance By 100,000 Victory Bond Buyers Of Boston Is Expected

The Massachusetts Institute of Technology joins in active collaboration with the Army, the Navy, the Office of Scientific Research and Development and other branches of the government to present this gigantic exhibition "Victory in Science" for the Victory Bond buyers of Greater Boston. This show features the best kept secrets of the war including many of the devices which were largely responsible for bringing victory to the Allies. For the first time such scientific marvels as radar and jet propulsion are released for careful scrutiny by the general public.

One hundred thousand Victory Bond buyers from this vicinity are expected to throng the Institute grounds during the weekend. The exhibition will be open Saturday, Sunday, and Monday from 2:00 P.M. to 9:00 P.M. Two of the main attractions will be a dramatic sea-air rescue enacted at 3:00 P.M. on each of the three days on the waters of Charles River Basin, and afternoon and evening performances of an actual fire fighting routine on the grounds between the Technology building and the River.

The exhibit is divided into five sections according to location on the Technology grounds.

CHARLES RIVER BASIN AIR-SEA RESCUE

At 3:00 P.M. on Saturday, Sunday and Monday a Coast Guardsman, playing the part of a crashed pilot, will be placed on a simulated

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The Tech

Vol. LXV Saturday, November 10, 1945 No. 34

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STUDENT SUBSCRIPTION, $1.50 Per Year

MAIL SUBSCRIPTION, $2.00 Per Year

Published every Friday during College Year, except during College Vacation and the third week in October.

Represented for national advertising by National Advertising Service, Inc., College Publishers Representative, 420 Madison Ave., New York, N. Y.

Member, Associated Collegiate Press

Entered as second class matter December 9, 1944, at the Post Office at Boston, Mass., under the Act of March 3. 1879.

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VICTORY IN SCIENCE

Three months ago, the signing of the armistice on the deck of the *U. S. S. Missouri* brought to a successful climax nearly four years of desperate struggle, into which every element of our nation poured its life, labor, and resources. We were too slow to wake up to the threats to our civilization, and, after the storm broke, it was only the most cooperative determination to preserve our ideals which saved the world from domination by ambitious powers bent on self-aggrandizement which would have plunged the world back into the dark ages.

In this all-out effort, the educational institutions of our country played a vital role; they served as ready-made centers for housing and training officers and specialized personnel; their faculties provided able experts for numerous emergency boards and committees; and their laboratories became centers of research and development on new weapons and instruments of war. Although the public frequently looks upon most of our academic scientists as visionary, impractical long-hairs, the record of this war demonstrates their vision, sound judgment, and practical skill to be one of the most significant sources of national security and strength.

This week we are presenting a survey of the accomplishments of the Massachusetts Institute of Technology in building victory in World War II; we feel we are just in being proud of our record. Outside of the limitation of space and the fact that some of the phases of research conducted here are still classified as secret, we believe that we have made no important omissions.

This week-end, you—the public who invested billions of dollars in government bonds—are being given an opportunity

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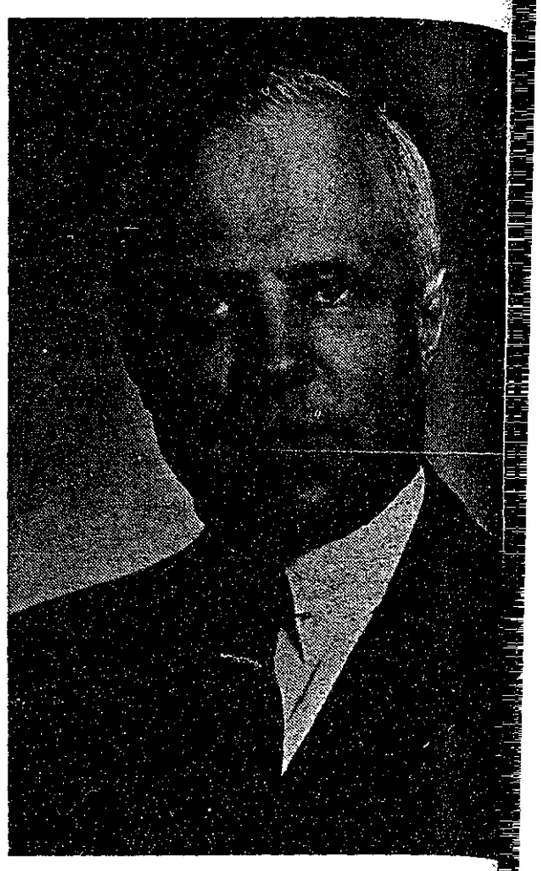
In The Spotlight

The logical choice for this week's SPOTLIGHT is the scientist, educator, and administrator who guided the Institute through the difficult war years during which the scientific marvels on display this weekend were developed—our President, Dr. Karl Taylor Compton.

Born in Wooster, Ohio, on September 14, 1887, Dr. Compton took his undergraduate work at Wooster College, from which he received the degree of Bachelor of Philosophy in 1908. He did advanced research and teaching at Reed College (Portland, Oregon) and at Princeton University. In 1930, when he received the call to come to M.I.T. he was chairman of the Department of Physics at Princeton.



PRES. KARL T. COMPTON

Received Rumford Medal

Dr. Compton is the author of many technical works dealing with his research in photoelectricity, ionization of gases, soft X-rays, spectroscopy in the extreme ultraviolet, fluorescence and dissociation of gases, and electric arcs. Perhaps his most important contributions to science are in the fields of thermionics — the study of electron emission from hot filaments—and the investigation of matter by means of light waves. Among the many awards he has received is the Rumford Medal, one of the world's most distinguished scientific honors.

In World War I, Dr. Compton, who has always taken an active part in civil and national affairs, was engaged in the development of submarine detector devices for the United States Army Signal Corps, and was later appointed Associate Scientific Attache at the United States Embassy in Paris. He was appointed by President Roosevelt in 1933 to head the Science Advisory Board, a group which considered the relation of science to the activities of the Federal Government, and he served on many other important pre-war boards and commissions.

Service With O.S.R.D.

In 1939, he was named a member of the War Resources Board, and a year later he became a member of the National Defense Research Committee, operating under the aegis of the Office of Scientific Research and Development. Three years later he was one of the three distinguished scientists appointed by President Roosevelt to study and report on the nation's rubber reserves. Dr. Compton served as Director of the Field Service the O. S. R. D., a group which headed by the Institute's for Vice-President, Dr. Vannevar Bu he has made several trips to European and Pacific war fro for the O. S. R. D., and retur only several weeks ago from mission to Okinawa, Manila, Tokyo.

Within the past several mon Dr. Compton was appointed ch man of the Executive Council the Research Board for Nati Security. This Board will funct in the period between the diss tion of the O. S. R. D. and formation of a permanent gov ment advisor committee to ordinate scientific activities.

M.I.T. and the nation are pr of Dr. Compton, under whose liant leadership the causes science and humanity have greatly advanced.

Orders For Senior Rin To Be Taken Wednesd

Orders for Senior rings members of the Classes of 1 and 2-47 will be taken on W nesday, November 14 in Bu ing 10 Lobby from 11:00 A until 3:00 P.M. A represen tive of the L. G. Balfour Co. will be present to t measurements. The rings co in three sizes and in dark light finish. The numerals will be engraved on rings dered by students in 2-47, those in the Class of 10-46 h their choice of either '46 or

Details Of Radar Now Disclosed

MIT Radiation Lab Had Vital Role In War Effort Through Radar Research

Submarine Detection By Microwave Radar Among Many Projects

The M.I.T. Radiation Laboratory, e world's largest organization of kind, had its origin in Novem-r, 1940, when Dr. Vannevar Bush, en head of N.D.R.C., the National fense Research Committee, ap-inted Pres. Karl T. Compton of I.T. as head of a special section the Committee to develop detec-n devices of all sorts. Since that e it has grown tremendously, w having a budget of $4,000,000 month, and a staff of scientists d engineers estimated at 20% of nation's top-flight physicists.

adiation Lab was originally mmissioned to develop microwave ar, a task which many high king physicists considered im-sible, or at least so in time to of any use in the war effort. roximately 2 billion dollars th of microwave radar equip-t has been built since that e, and it has virtually displaced rly all of the longer wave types.

British Send Delegates

many cases where it was im-sible to get equipment into com-cial production quickly enough military demands, the labora-also functioned as a factory produce small quantities of y needed materiel. One par-ar piece of high power radar aratus was considered so valu-that it took a decision by Prime ster Churchill to take the set from RAF anti-buzz-bomb to aid General Patton on the nent.

the summer of 1940 the British rnment sent a scientific mis-to this country, headed by Sir y Tizard, to cooperate with the rowave Radar Committee," h was appointed by Dr. Comp-nd headed by Alfred L. Loomis, w York lawyer, financier, and tist. After investigation of the netron, a British development e microwave field, the com-e decided that the problem sufficiently important to re-quire a laboratory of its own, with extensive powers and a large staff.

Tech Chosen Home

In October, 1940, Dr. Compton agreed to give the proposed laboratory a home at Tech, and Dr. Lee A. DuBridge of the University of Rochester was selected as its Director. It was decided that the laboratory, while affiliated with Tech, would not be as closely connected as such organizations usually are, but would work directly thru the Microwave Committee and the N.D.R.C.

Dr. DuBridge divided the laboratory into five main groups, each doing research on one of the five principal parts of a radar set. These groups were headed by Dr. I. I. Rabi of Columbia University (now Associate Director of the Laboratory), Dr. L. A. Turner of Princeton, Dr. W. M. Hall of Tech, Dr. K. T. Bainbridge of Harvard, and Dr. A. J. Allen of the University of Pittsburgh. Later Dr. L. W. Alvarez of the University of California, was made head of a new group to direct the assembly of the separate parts into a complete system.

Training School Opened

On November 11, 1940, work was begun on the design of an improved night-fighter radar. In the process of developing this unit it was discovered that it had many unsuspected advantages in spotting ships on the surface of the sea. Accordingly, work was begun to modify this unit for sea search work. Even before this work was begun, experiments had led to the development of a new unit that led to blind anti-aircraft-fire control, which proved to be one of the most valuable units developed, being used for many purposes other than that for which it was designed.

About this time the Laboratory began to act as an advisor to the armed services. Army and Navy officers began to visit the Laboratory with new requirements and suggestions for radar equipment. In 1941 a training school was opened by the Laboratory at Tech and later transferred to the Harbor Building on Atlantic Avenue in Boston. Here Army and Navy officers were given expert instruction in the operation of the latest types of radar equipment. (See story "Radar School.")

Unskilled Labor Inducted

In the summer of 1942, the Laboratory's "sea-search" radar, an outgrowth of the first night-fighter set, was being used in the battle of the North Atlantic, and is credited with 50 per cent of the U-boat sinkings in that area. There was no longer any doubt as to the practicality of "microwave radar."

Unable to recruit enough skilled help, the Laboratory was forced to hire hundreds of unskilled workers and train them for special jobs. Eventually over 1400 women and girls were hired and trained as technicians, draftswomen, or machinists. During training periods trainees built simple but urgently needed laboratory apparatus.

British Lab Near Field

During 1943 the British Branch of the Radiation Laboratory was established for the purpose of providing closer liaison with the British on an important radar set

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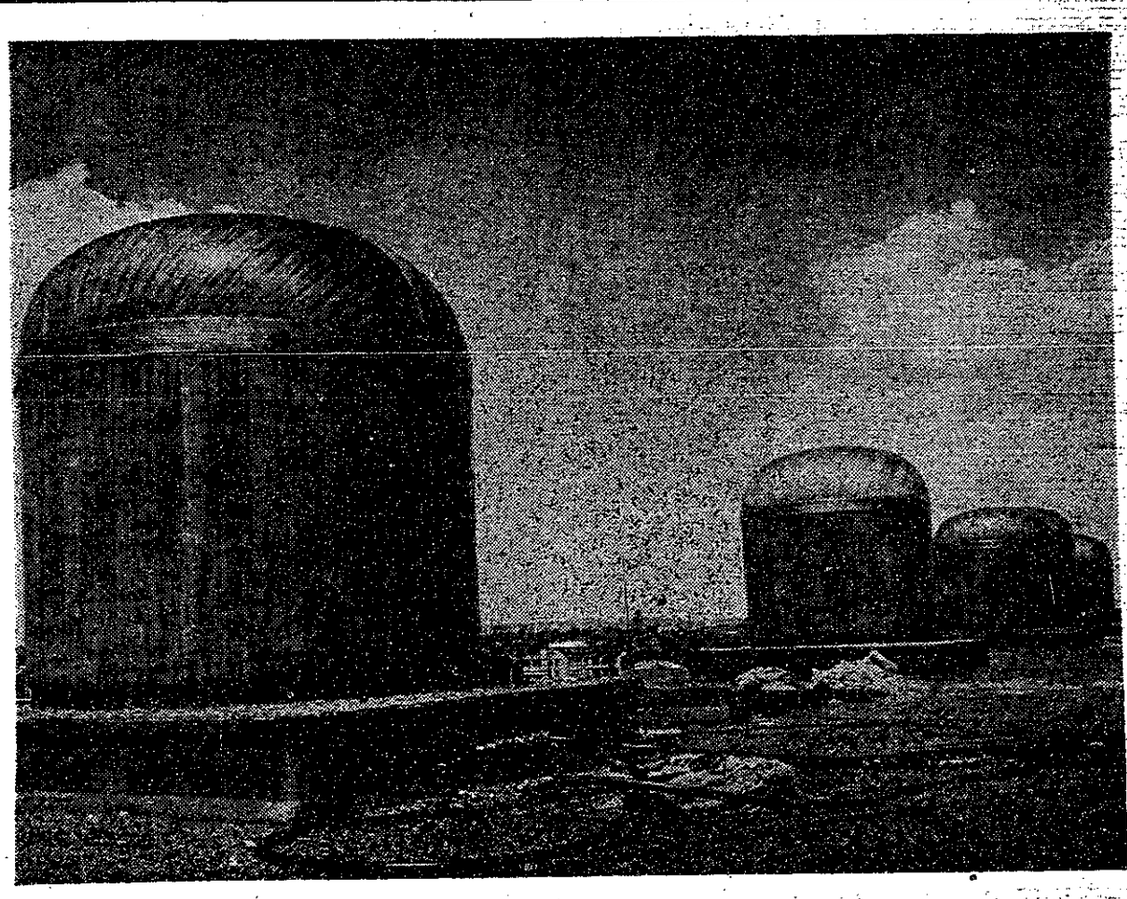
RADOMES ON ROOF OF M.I.T.



The Radiation Lab. operated under a security blackout for five years while developing some of the major types of wartime radar. But, the radomes pictured above, which excited so much speculative comment, were primarily to protect experimental antennas from the Cambridge weather.

Tech Blood Donors Helped War Effort

Students And Staff Gave 4 Thousand Pints

Among the more inconspicuous but nevertheless vital M.I.T.'s contributions to the war effort was the laudable work of the Technology Blood Donor Service.

This service, inaugurated on February 16, 1944, amassed the amazing total of 4212 pints of blood given directly through its efforts. This is an average of 234 pints per month during the eighteen month period of its existence, which ended with the end of the War with Japan on August 14, 1945. Even this total does not include the many donations which were inspired by the campaign, but appointments for which the donors made on their own.

A review of the records of the service reveals that there were 190 members of the Gallon Club, (8 donations) including 14 students and 41 faculty members. The service also boasted of six members in the very elite Two Gallon Club, two of which had donated fifteen pints and made appointments for the sixteenth when V-J Day arrived.

SWAMPED!

Prof. B. Alden Thresher, the Institute's Director of Admissions. The Admissions Office is currently the busiest at Tech, with some 3000 inquiries being received each week from prospective students, and with hundreds of the hopefuls visiting the office for personal interviews. Most of the men interviewed are veterans of World War II.

Victory In Science

(Continued from Page 1)

wreck anchored in the Charles River between the Massachusetts Avenue and Longfellow Bridges offshore from the Institute Buildings. An alarm siren sounded over the public address system will mark the beginning of an actual rescue directed by the Operations Officer of the Coast Guard Air Station at Salem. A patrol plane will pass over the wreck, while the survivor will attract its attention with colored dye in the water, rockets from a Very pistol, and a smoke grenade. The patrol plane will drop a rubber boat and a Gibson Girl, the famous radio set which has helped save so many lives.

Soon a crash boat will rescue the survivor; then he is to be picked up directly from the boat by a helicopter which will deliver him to a specially roped off section on the Institute grounds.

Sonar

The underground counter part of radar, called Sonar, will be on exhibition in the Navy Barge anchored in the River opposite the Great Court. This device was of tremendous value in the detection of Axis submarines during the Battle of the Atlantic.

Navy Boats

Naval surface craft will be moored on the Cambridge side of the Charles River Basin so the public may inspect them. On display will be PT boats and several LCVP's (Landing Craft Vehicle Personnel) which are ordinarily used to transport a jeep and a few men.

BETWEEN WALKER MEMORIAL AND MAIN BUILDING

Fire Fighting

Twice daily, men from the Navy's Fire Fighting School in Boston under Lieutenant Commander M. A. Heison, will demonstrate ship board fire fighting routine. They will light a gasoline fire in a large metal tank and will demonstrate the latest methods in combating it, the use of liquid fog or liquid foam. Modern equipment such as portable power pumps, heat proof helmets and suits, and rescue breathing apparatus will be shown in action.

Army Quartermaster Show

This large display of the facilities and equipment provided troops by the Quartermaster Corps is broken down into four parts: clothing, food, fuels and lubricants, and mobile equipment. The types and varieties of food shown were developed for highest efficiency and health under all conditions and climates, and include dietic formulas and concentrated rations. The new fuels and lubricants developed for jungle heat and aretic cold will function efficiently in many types of engines. The mobile equipment on display includes laundries, kitchens, etc. to give our troops some comforts while in the field.

Flame Throwing Tank

The famous Sherman tank with a flame thrower mounted in the turret was a most effective weapon in World War II. It can throw a sustained burst of flaming jellied gas more than hundred yards and was extensively used in the South Pacific to burn the Jap defensive troops out of the coral caves.

GREAT COURT
Radar
For Bombing, Shipboard and Night Fighter

These sets illustrate three of the most useful phases of radar. Bombing radar is designed to guide bombing planes to the target and to cause the proper time lead in releasing the bombs. It presents an exact visual map of the target terrain as this ground is interpreted by radar signals.

Ship radar is used by our fighting vessels in the detection of friendly and enemy ships even under the most adverse weather conditions. It aids in navigation by the detection of nearby land masses.

The night fighter radar is installed on the plane itself. It is specially designed to guide the pilot to the tail of the enemy plane so that he may successfully fire his guns into the target.

SCR 584 Radar

The 584 is a mobile set mounted on a ten ton truck. This most versatile of radars determines accurately the direction, range, and elevation of the target from the gun. It automatically follows a moving airplane and consantly directs the anti-aircraft gun. The crew only has to load; the rest is done automatically. This radar was extensively used in close support bombing and as a defense against the V-1.

Radar Directed Guns and Search Lights

Huge sixty-inch search-lights will be shown automatically following a target plane in the sky. Two types of radar controlled anti-aircraft guns are exhibited. Demonstrations of huge 120 mm. super range sub stratosphere guns will be made, while the public will be invited to direct the smaller 40 mm. guns on a moving target. This gun coupled with a Mark 51 remote controller is commonly used on U. S. fighting ships.

GCA Radar

With Ground Contral Radar a controller at an airfield can guide a pilot in for a perfect landing even in complete fog or darkness. It tells the controller exactly how far up and away from the air field the particular plane is flying.

Parabolic Focus

A radar set includes both transmitter and receiver. The transmitter sends out a powerful signal which is reflected by an object such as an airplane to a receiver which records the image. The parabolic antenna shown in the exhibit is often used to focus the beam on the receiver. For the demonstration an outside source will throw a radar beam on the focus which casts it on a gas filled bulb designed to light up when hit by the beam.

Azon Trainer

The public will be able to try to keep a bomb "on target" as it falls to the ground by means of this ingenious bombing training device.

Armor Against Frangible Bullets

A plane will be shown with special armor for gunnery training with frangible bullets. In this training the student shoots real bullets which being frangible, explode into fragments upon hitting the plane. With each hit a light on the plane goes on, so both instructor and gunner can observe the latter's success.

Miracle Harbor

The miracle harbor display, called the Mulberry Mystery Project, is a miniature reproduction of the famous, completely man-made, prefabricated harbor which played such an important part in the Normandy Invasion.

Avenger Torpedo Bomber

This plane is one of the largest used on carriers and is therefore equipped with a hydraulically operated wing folding appara-

which will be demonstrated at the display.

The Avenger was the Navy's torpedo plane during the last three years of the war, first seeing action in the Battle of Midway in June, 1942. The plane carries a crew of three and has a speed of better than 250 miles per hour and a range of more than 1000 miles. It carries one torpedo or a ton of bombs and three 50 caliber machine guns.

Edgerton Flash Unit

This unit, to be demonstrated regularly at the display, creates such a brilliant flash for night reconnaissance that a photograph plane can get good details of the target at a height of 10,000 feet.

Talking on Light

In this device the sounds of the voice are translated into light and transmitted on a beam of light to a receiving apparatus which retransmits the light back into sound to be heard over a loud speaker.

NAVY SPECIAL DEVICES

Basic Training Turret

The hydraulically operated turret can be moved rapidly up and down and from side to side, in order to keep it on a swiftly moving spot of light which is used as the target in this gunnery training device. The public can operate this device at the display.

Gun Air Instructor

This apparatus is used to train pilots in placing their guns on target by aiming the whole plane. The student is placed in a cockpit, where by use of his "stick" and rudder control he shoots beams of light on diving picture planes which are cast on a screen by a movie camera.

Dual Projector Trainer

This device, similar to the Gun Instructor, is used in the training of anti-aircraft crews. The public may operate this device at the exhibition.

Star Recognition Trainer

This special Navy device is used to teach identification of stars and constellations, which is vital in navigation. Points of light are shown on an umbrella-like "sky" to show the relationship between stars at a certain time of the year and any part of the world. By moving the points of light, a situation for every time of the year and each part of the world can be created.

V-1 Robot Bomb

The V-1 is the bomb used by the Germans with such effect against England. It is a pilotless aircraft launched from a ramp, and flies to the target, where a nose mechanism puts it into a dive and explodes it.

Recoilless Gun

This is the sensational new weapon which fires a 75 mm. shell but can be carried by two foot soldiers. It can be set up and put into operation very quickly.

Jet Propulsion

Jet propulsion is the new miracle which propels airplanes at high speeds. It was of great value in the development of newer and faster fighting planes in World War II.

BACK OF MAIN BUILDING

Van de Graaff Generator

This two and a half million volt generator was invaluable in nuclear research. It also developed sufficient power for the X-raying of armor plate and guns to discover any flaws existing in the metals.

Automotive Laboratory Display

Shown here are Rolls-Royce and Allison Engines, an 1800-horsepower radial aircraft engine, an adjustable pitch propeller, a B-29 turbo-supercharger, and cutaways of engines to show the operation of the internal combustion engine.

Wind Tunnel

In the Wright Brothers Wind Tunnel, one of the largest in the country, there is a huge power fan for creating winds to test models of proposed aircraft.

MAIN BUILDING

Atomic Bomb Movies

On the second floor of Building 10, movies will be shown about the destructive atom bomb. In this section there will also be atomic bomb photographs.

Navy Exhibition

This includes accurate scale models of many of the Navy's most famous fighting ships, gun models, and a thrilling photographic story called "Power in the Pacific" (see story).

First Floor Open

The first floor of all the main building will be open for a routine inspection of Technology's educational facilities.

Guides, chosen from the undergraduate student body of the Institute, will be available to make this gigantic exhibit more interesting, worth-while and enjoyable for those who bought bonds to make some of the achievements shown possible.

8,776 Alumni In Armed Forces

Group Includes Many High-Ranking Officers

According to the latest figures available, a total of 8,776 alumni of the Institute, or 23.6 percent of all living former students, have served in the armed forces of the United States and allied nations during World War II. Of this group, 148 have made the supreme sacrifice.

A very high percentage of Technology's alumni in the services are in positions of great responsibility; our service group is headed by 92 generals and 35 admirals. Some of the better known flag officers are General George C. Kenney, '11, Pacific Air Commander; Lieutenant General James H. Doolittle, '24, Eighth Air Force Commander; Major General Leslie R. Groves, '17, Director of the Atom Bomb Project; Vice Admiral Emory S. Land, '06, Head of the Merchant Marine; and Rear Admiral Edward L. Cochrane, '20, Chief of the Bureau of Ships of the United States Navy.

Two alumni, General Doolittle and Lieutenant Colonel Jay Zeamer, Jr., '40, have received their country's highest award for valor—the Congressional Medal of Honor. General Doolittle received the Medal of Honor after leading the famed first raid on Tokyo, while Colonel Zeamer received the Medal after an epic struggle against the Japanese in a B-17 over Bougainville.

Talk On Seabees Is Delivered By Admiral L. Combs

Rear Admiral Lewis B. Combs, Assistant Chief of the Bureau of Yards and Docks of the United States Navy, addressed a diversified audience in Huntington Hall late Friday afternoon.

Admiral Combs' address dealt chiefly with the brief history and remarkable exploits of the Seabees during the war. He traced their history from Seabees inception in the war to their present organization citing many instances where this organization, comprised of all branches of the building and construction industry, helped to bring about the successful operation of our Armed Forces in the various theatres of war. The Admiral's talk was supplemented by moving pictures which showed vividly Seabees in action during the Aleutian campaign.

Combs' address was presented under the auspices of the students of the department of Building Engineering and Construction who are members of the student chapter of the Associated General Contractors of America. The meeting was open to all organizations comprising divisions of the building industry, architects, engineers, and contractors.

Large November Issue Of T. E. N. Now Being Sold

Co-eds At Institute And Mathematics Dept. Are Feature Articles

The November issue of T.E.N. is on sale in the Lobby of Building 7 this weekend during the "Victory In Science" show. This issue will be larger than usual and will include many more articles.

Heading the table of contents is the feature "This is M.I.T." which will describe the inner workings of the Mathematics Department. This article has been written especially for T. E. N. by Professor Henry B. Phillips, head of the department.

Part II on The Nitroparaffins by Edward M. Kosower, 2-48 and Kenneth B. Wiberg, 2-48 will also appear in this issue. Another chemical article will be Bakelite-Pioneer in Plastics by Edwin A. Schlang, 10-46. Of interest to biological students will be an article entitled, Yeast in Nutrition by Sanford M. Siegel, 2-48. An article on Thermodynamic Media by Rodman Jenkins 10-47, will catch the eye of some potential physicist.

A departure from the hard and fast factual writing of scientific papers will be "That Singular Anomaly" written by a group of the Institute co-eds. This article traces their history on the campus and in the class-rooms and is supplemented by statistics and illustrations.

Differential Analyzer, Used For War Projects, Will Solve Industrial Problems

100-Ton Machine Exhibited Recently For First Time

A new type of differential analyzer, a 100-ton calculating machine which marks a significant advance in the field of mechanized mathematics, was given its first public demonstration before a disinguished group of scientists, engineers, and officers of the United States Navy and Army in the Center of Analysis at the Institute recently.

Designed for the solution of scientific and industrial engineering problems, this new electro-mechanical giant was assigned three years ago to various important war projects, the most formidable of which was the urgent task of computing range tables for the guns of the United States Navy. Built to accommodate as many as three complex problems at once, the machine's power could be directed to the solution of other problems such as those of fire control and radar antenna design without interrupting its main program.

The new analyzer is the latest development in a distinguished sequence of mathematical aids in Technology's Center of Analysis, which was established in 1939 for the purpose of encouraging and assisting technological progress in all fields and making available to scientific institutions, government agencies, and industry the means of carrying out intricate mathematical processes economically. No small part of the importance of this division of the Institute's department of Electrical Engineering lies in its contributions to teaching and research.

Its war service over, the Institute's new instrument of mechanized mathematics will turn to its original objective, the solution of peace-time problems in a field of usefulness which includes every branch of science and engineering.

The new differential analyzer is, in effect, a mathematical automaton, designed not merely to relieve human brains of the time-consuming drudgery of diffcult calculation and analysis, but to attack and solve mathematical problems which are economically beyond the reach of ordinary methods of solution. As a tireless ally of science it achieves economy of time and labor and liberates man's thinking for creative effort.

Scientific announcement of the differential analyzer has just been made in the Journal of the Franklin Institute in a joint paper by Dr. Vannevar Bush, formerly Vice-president of the Institute, and now President of the Carnegie Institution of Washingon and Director of the Office of Scientific Research and Development, and Dr. Samuel H. Caldwell, Director of the Institute's Center of Analysis.

The new differential analyzer contains approximately 2,000 electronic tubes, several thousand relays, about 150 motors, and nearly 200 miles of wire. It occupies a laboratory specially constructed to support its great weight and has a special ventilating system to dissipate heat generated in the processes of operation.

The original differential analyzer, designed by Dr. Bush and his associates and built in 1931, was entirely a mechanical machine, and the solution of problems required manual setting of gears and other connections. In the new machine these settings and connections are automatically accomplished by electrical "couplings," an instantaneous process controlled by punched paper tapes. For ordinary operations the huge machine requires only one operator. The symbols of the mathematician representing the problem for which a solution is desired are translated into a "language" which the machine understands. This "language," a code punched on a paper tape, is transmitted to the machine which automatically selects the various units required for the process of computation.

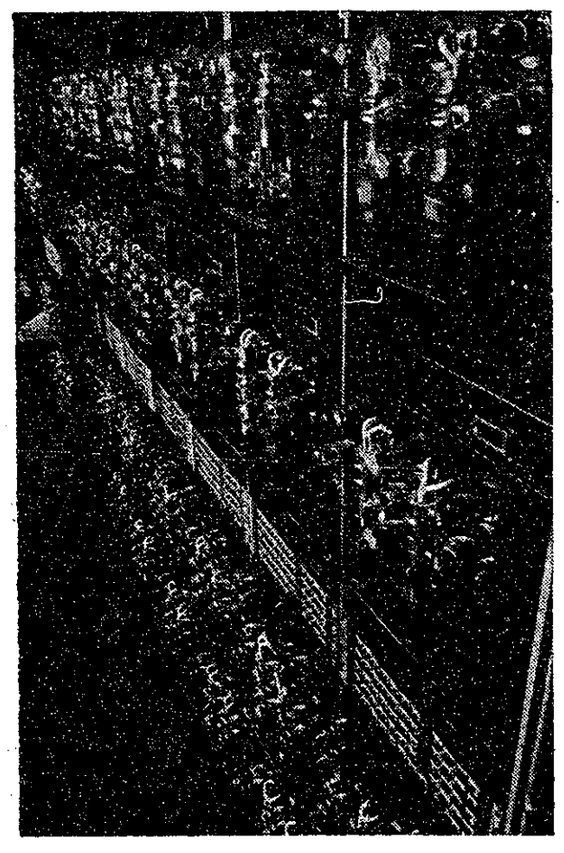
The differential analyzer has proved extremely valuable for such widely diversified problems as the analysis of information on earthquakes, sound waves, geophysical exploration, the rates of change in chemical processes, atomic wave functions, analysis of complex vibration problems, studies of the behavior of electrical machinery, and power transmission problems, investigations associated with the design and performance of aircraft, analysis of radar wave patterns, and the study of cosmic phenomena.

Unlike conventional types of culating machines which ope on numbers, the new differe analyzer deals with problems volving rates of change among riable quantities. The solution a differential equation is not a number; it is a numerical hi of the concurrent instantan values of two or more varia These solutions may be prod either graphically or numeric or in both forms. A graphical tion consists of a curve drawn tomatically by the machine, s ing the relation between any variables appearing in the diff tial equation. A numerical sol consists of a printed table o corresponding values of the ables at any convenient inte

In the differential analyzer variables of a problem are re ented on the shafts of a numb mathematical units. The rot

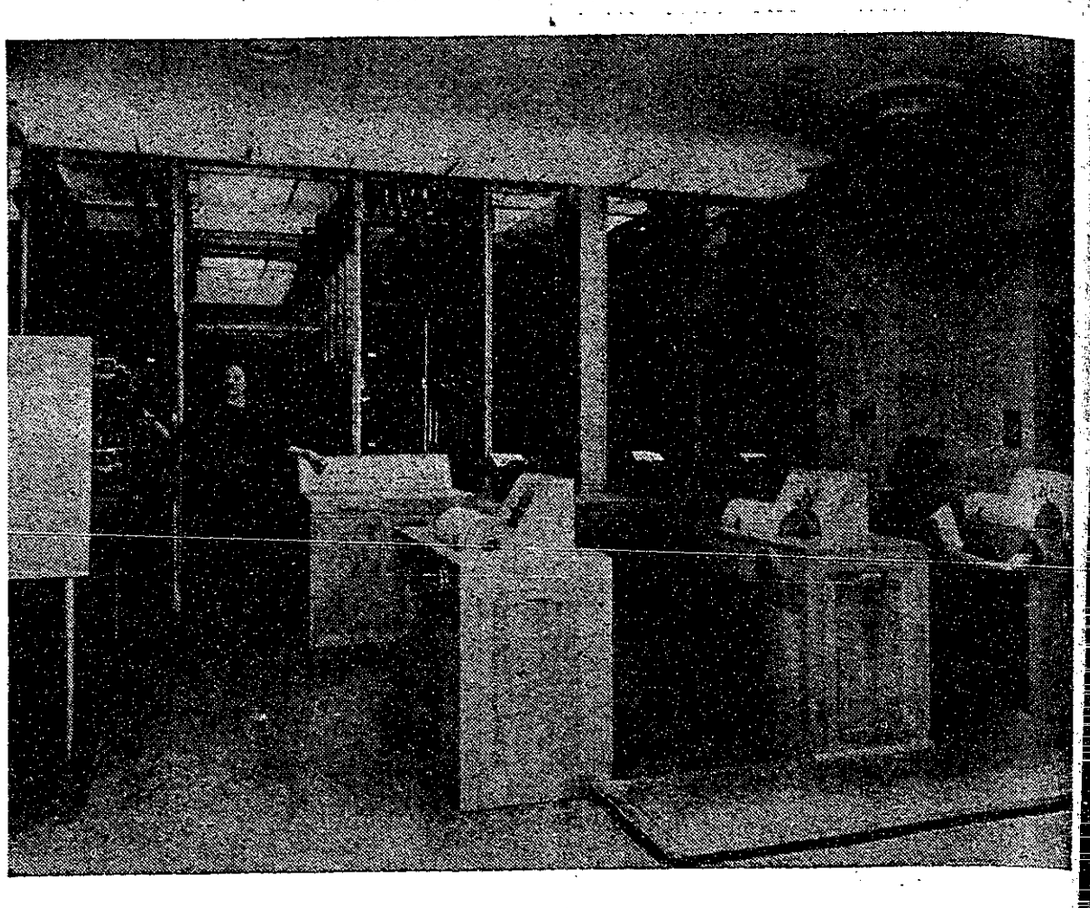
(Continued on Page 12)

NERVE CENTER



Heart of the differential analyzer is the panels shown.

2000 ELECTRON TUBES SPEED COMPUTATIONS



Automatic electric typewriters (in front of panels) recording solutions complex differential equations; machine contains 200 miles of w and 2000 electron tubes.

Tech Has Sole Radar School

Dean E. Moreland Leads Organization Of Center; Bowles and Barrow Aid

Harbor Bldg. Houses School; Nearly 9000 Officers Are Trained

In the middle of 1941 when it had ecome quite apparent that, in the vent of our entrance into war, he U. S. Army and Navy would eed many officers trained in the chnique of radar, the M.I.T. adar School was established. adar was a new weapon whose ilitary value had been well monstrated by the British, and e Institute was well suited to ovide the essential training as ny of its staff were then engaged work dealing with ultra-high- equency and microwave radio hniques.

The Radar School was organized der Dean of Engineering Edward Moreland, and Professors Ed- rd L. Bowles and Wilmer L. row of the Electrical Engineer- Department. Originally situated the M.I.T. Campus, the expand- school was soon moved to larger rters in the Harbor Building on antic Avenue in Boston, where occupied the upper five floors the roof. Subsidiary branches e located elsewhere in Boston. school was a complete train- unit, containing classrooms, oratories, shops, gymnasiums, all other necessary facilities.

Harbor Building overlooks ton Harbor, and consequently y interesting radar targets e available.

ne intensive course, providing ruction in radar, loran, sonar, combatative measures against y radar, was increased from e months in the early days of school, to a four and one-half th course as the new devices equipment became available tudy. Many of these machines pioneered by the M.I.T. Radia- Laboratory, which worked in conjunction with the school l times.

taff Reached 170 At Peak

e daily program of instruction ly consisted of lectures together with study or supervised problem work, and several laboratory hours. Supplementary work was provided during the evenings two nights a week. The teaching staff, comprised of Army and Navy officers and civilian instructors from the Institute, grew with the student population and eventually reached a peak of 170 men. Specialization was provided for the Signal Corps, Coast Artillery, Air Force Officers of the Army, and Airborne and Shipborne Specialists of the Navy, over and above the regularly scheduled courses; and with equipment becoming increasingly specialized it was necessary to separate the Army and Navy courses.

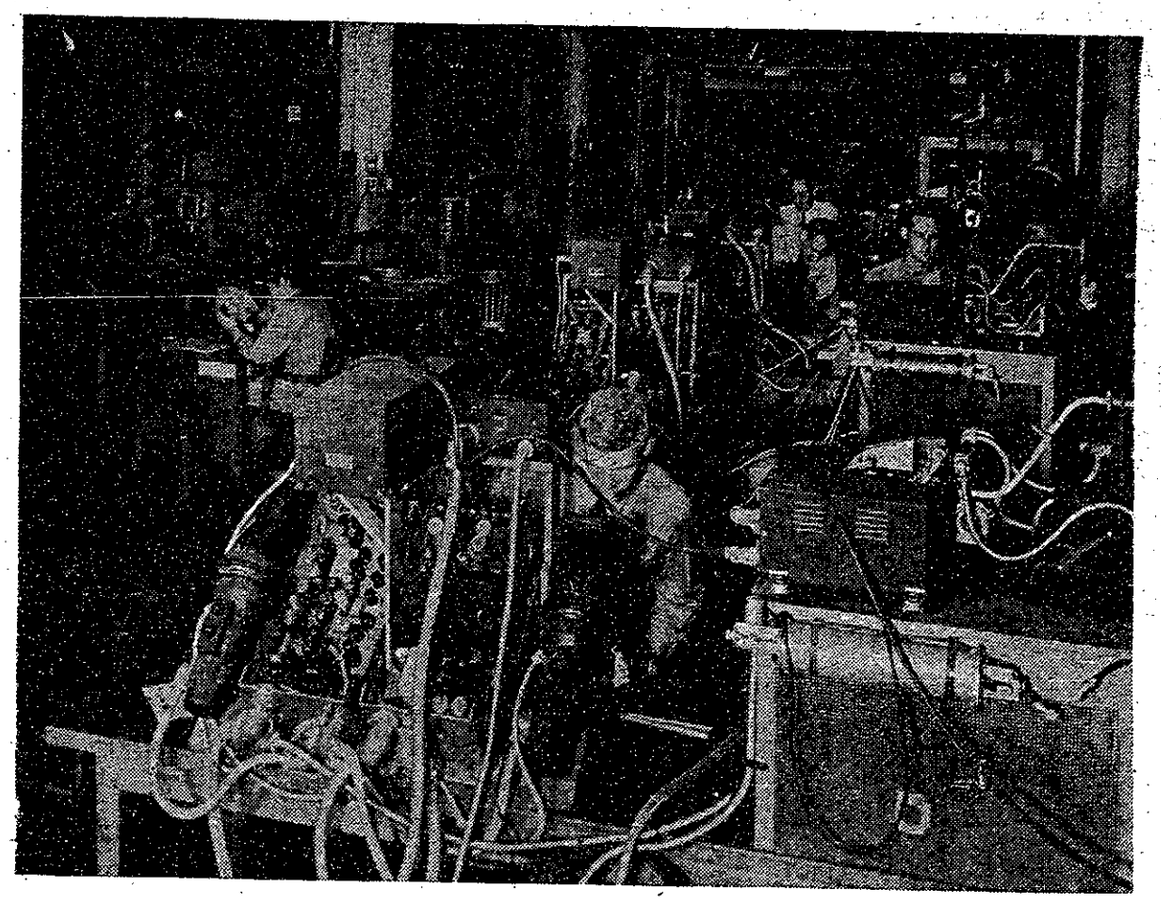
Training aids were used extensively throughout the program. Demonstration boards, films, slides, and charts, as well as the confidential textbook, "Principles of Radar," written by the instructing staff, were included. The instruction was further supplemented by practical instruction in representative types of pertinent service equipment provided directly by the Army and Navy. Thus students were always well informed on the most up-to-date devices developed.

Peacetime School Contemplated

The only school of its type in the world, the center has graduated just under 9000 men, including students taking both regular and refresher courses. The Army has completed its program at the school, while the Navy will continue until December 15. Plans are now under consideration for continuing the school at the Institute as a regular course, but only for Army and Navy personnel and leading to a degree of Bachelor of Science upon graduation.

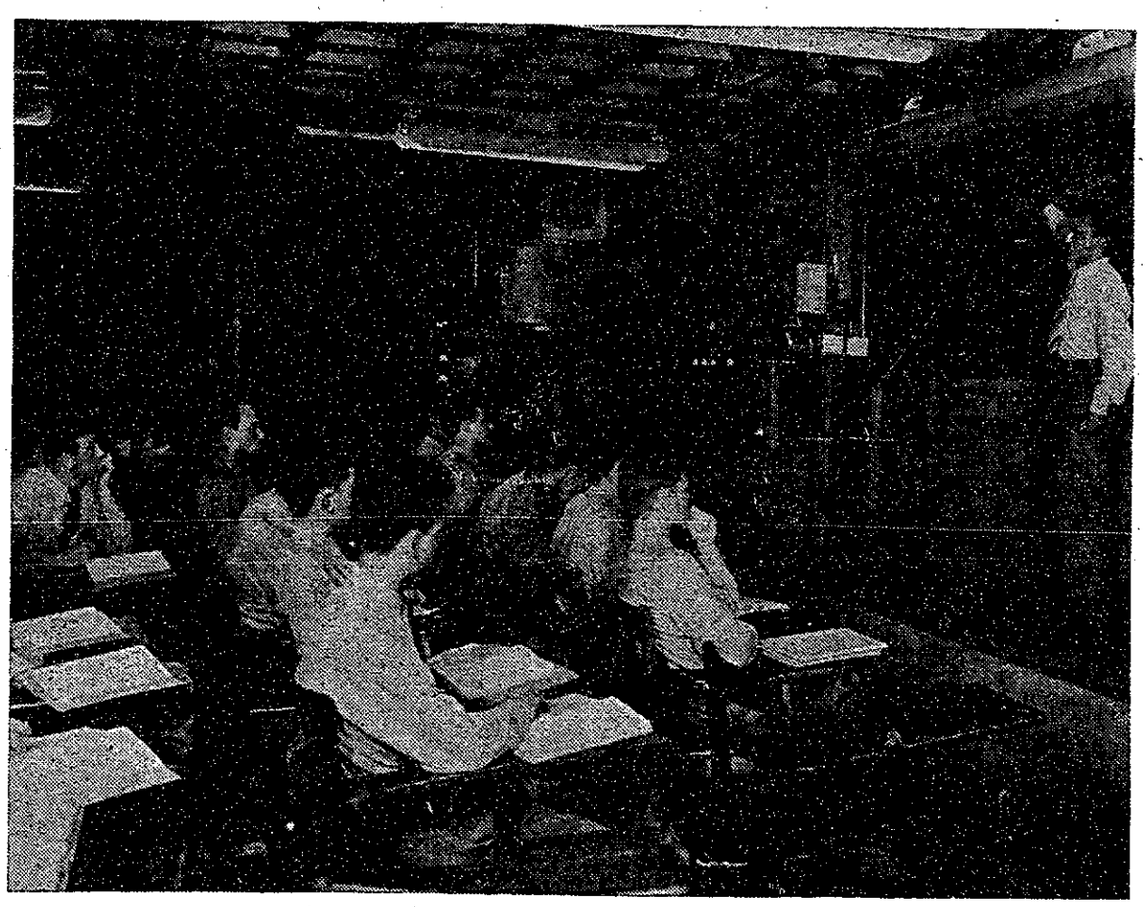
The secret Navy Barge on the Charles, so familiar to Technology personnel now, was operated under the auspices of the school as a housing for sonar and other underwater detection equipment. It is open for the first and perhaps only time for inspection by the general public this week end, for the show, "Victory in Science."

NAVY AIRBORNE RADAR LAB.



Above is a section of the Navy Airborne Radar Laboratory of the M.I.T. Radar School. Close to 9000 men have been graduated from the school since its inception in 1941.

LECTURE ON SHIPBOARD RADAR



Navy students learn details of shipborne radar at the M.I.T. Radar School in the Harbor Building, Boston.

D.I.C.

(Continued from Page 1)

almost $8,000,000, but by 1945 this figure had increased five fold, and during the entire period of operation the D.I.C.'s contracts totaled close to $100,000,000 for war research and training programs.

An extraordinarily low overhead was received by the Institute, an index both of the efficiency of the Government war research program, and of the effect of the large volume of expenditures.

Radiation Lab.

(Continued from Page 3)

using both British and American parts. The British branch was soon to become closely linked with the fighting fronts on the continent, in which capacity it acted as an advisory body on the operational use of radar. Eventually the British branch employed 125 personnel who could be found not only in every important headquarters, but also with the troops in the field wherever new radar uses were being worked out. General Patton commented that this infiltration of civilian scientific advisors into the ranks of the military "is the way that wars not only can, but should be run." Radiation Laboratory experts played important parts in the campaigns in Africa, Sicily, Italy, and France, as well as in the strategic bombing campaigns from 1943 on.

Radar equipment developed at the Laboratory has been employed not only to detect and destroy our enemies, but also to save the lives of our own soldiers.

New Purpose Discovered

Late in 1941 an idea occurred to one of the original group of scientists that the properties of radar would be ideally suited to the task of bringing planes in for blind landings under adverse weather conditions. By use of very accurate radar equipment it was possible for a controller on the ground to transmit by radio to the pilot of a plane his exact position relative to the landing field, and any obstructions which might be in his way. In this way pilots have been known to be "talked down" for a landing under conditions such that the only way the pilot knew when he had landed was by the bump of his wheels on the runway. One of the principal advantages of Ground Controlled Approach, GCA as it is called, is that it requires no special equipment in the plane itself. It works equally well with a B-29 and a Cub.

Lab Now Closing

Today the Laboratory is preparing to close down. Most of the research work is being transferred to Army, Navy, and industrial centers, and preparations are being made to release the staff. Already on the designing tables, or in the pre-production stage, are enough radar types to keep the armed services ahead of any competitive radar for at least another year.

Most of scientific and technical experts of the Laboratory will return to the jobs they left to take part in this tremendous undertaking, but a few will stay on to record the advances which have been made in the field of electronics as a result of these five years of intensive work. It is estimated that in this time the field has advanced as much as it would have during 25 years of normal peace-time research.

Hedlund Needs Men For Winter Season

Tech's Track Facilities Are Finest In Country

Oscar Hedlund, Tech's Track ach, has just announced that e winter season for track will n begin. During the war many rts were forced to suspend their ivities, but Track continued to et other schools, producing some the finest teams in this part of country. Now that the war is r, meets with other schools will ome even more frequent and ck offers men a chance to get a sport which is already well anized and can give them an y opportunity to engage in com- ition.

riggs Field is the finest in the t, with a very fast quarter mile er track and excellent condi- s for field events. The board k, one of the best of its kind, ocated just behind the field se. Inside the field house are most modern facilities for vering and dressing as well as iving medical attention. The k office at Briggs Field is open y afternoon from 3 o'clock until last man is through with his out.

not take into consideration her or not you have had any ous experience, but report now see what Track can do for you.

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riers Will Participate ross Country Meet

e M.I.T. Cross Country Team articipate in the New England Collegiate Amateur Athletic iation Cross Country Meet on ay, November 10 at 2:00 P.M. anklin Park.

Training Program In Crew Started; New Men Wanted

Graduation and the gradual disbandment of the Navy's V-12 program has seriously thinned the ranks of the M.I.T. crew squad, and an appeal for new men has been issued by Jim McMillin, head crew coach at the Institute. Many positions are available on the Varsity and Junior Varsity shells, and in order to assure an ample supply of experienced men, a training program has been instituted for November and early December in preparation for the Spring season.

Instruction will be given on the rowing machines at the crew house, which is located at the Cottage Farm Bridge. All men, particularly freshmen, who are interested in rowing are invited to attend the training sessions on Mondays, Wednesdays, and Fridays at 4:30 P.M. and at 5:15 P.M. Races are scheduled with Navy, Cornell, and Columbia; so a big turnout is needed in order to prepare enough men to meet this competition.

Soccer Team Schedules Coast Guard, Harvard

The M.I.T. Soccer Team will have its first game of the term next Friday, November 16, when it takes on the Coast Guard Academy at the latter's home field.

Since five men from the varsity Soccer Team are gone, there is a great need for good new men. Those who wish to try out are urged to report to the Field House during the early part of this week.

On November 24 the team travels to Harvard for its second game with the Crimson.

SWIMMERS!

Swimming Coach Gordon Smith has asked that all men interested in signing up for the swimming squad plan to be at the Alumni Pool on Tuesday, November 13, at 5:00 P.M. Freshmen will be eligible, and should realize that they will have an equal opportunity with upperclassmen. The success of next year's team, as well as the success of this year's team, depends upon the development of ability gained through practice and training.

The first meet of the season has been scheduled for Saturday, December 8, so it is imperative that conditioning start immediately. Coach Smith urges every man interested, whether or not he has signed up previously, to be at the pool Tuesday.

A.W.S. Fall Frolic Scheduled Next Fri.

Mrs. Karl T. Compton On List Of Chaperones

The "Fall Frolic," an informal all-Tech dance sponsored by the Association of Women Students, will be held in Morss Hall, Friday, November 16, from 9:00 P.M. to 1:00 A.M.

The dance will be chaperoned by Mrs. K. T. Compton, Dean and Mrs. Harrison, Dr. and Mrs. G. G. Marvin, Mrs. Margaret Alvord, and Mr. Gerald Putnam. Ticket sales will be limited to 400 unless the demand is extremely great in which case a maximum of 500 will be sold.

The Techtonians are scheduled to supply the music for the affair which the A.W.S. hopes to sponsor annually in the future.

Sailors Capture Schell Trophy

Greenbaum Tops Tech Individual Scorers

Last Sunday the Tech sailing team won the fifth annual William Schell Trophy regatta. Most striking characteristics of the event were cold weather and snow throughout most of the day. The result was that the sailors, nearly becalmed in the light wind, were faced with the unusual hazard of freezing.

This year the Schell regatta was attended by the largest number of teams since the beginning of the war. Fifteen of the seventeen colleges entered sent teams to the Charles River Basin, where the regatta was held. Tech's victory marked its seventh win out of eight major regattas this season. Following M.I.T., which had 95 points, came the Merchant Marine Academy of King's Point with 86 points, the Coast Guard Academy with 83 points, Holy Cross with 82 points, and the Naval Academy with 81 points.

For M.I.T. in the first division Leigh Brite, with Webb as crew, sailed in three races and Marvin, with Dick Lacy as crew sailed in the other one. Between them they amassed a total of 44 out of a possible 60 points. Dan Greenbaum, with Bridges and Licher alternating as crew, raced in the second division and piled up 51 out of a possible 56 points.

Individual high scorers were William Page of Coast Guard in the first division with 50 out of 60 points, and Dan Greenbaum of M.I.T. in the second division with 51 out of 56 points.

In addition to the snow and cold, darkness was another problem in the last few races. At the end of the meet, Professor Schell presented the trophy to the M.I.T. team.

Pres. Compton

(Continued from Page 1)

anisms which, with extremely great accuracy, followed the directions given by such fire-control computing devices as the Draper sight, and provided the essential link between the source of information and the final position of the gun. In both the Instruments Laboratory and Servomechanisms Laboratory, advanced courses were conducted for Army and Navy specialized officers to teach them the newly developed techniques.

The Chemical Engineering department, represented by Profs. Hoyt C. Hottel and Glenn C. Williams, and the Mechanical Engineering department, represented by Profs. C. Richard Soderberg and Ernest P. Neumann, cooperated in carrying out important special research in fuels and related problems of combustion. In waging mechanized war, the importance of special fuels cannot be over-estimated.

One of the busiest laboratories at the Institute has been the Laboratory for Insulation Research, under Prof. Arthur R. Von Hippel of the Electrical Engineering Department. The laboratory was devoted to the study of insulating materials and especially their characteristics in high-frequency (radar work is done at extremely high-frequencies) electrical fields.

With its Edgewood Arsenal greatly overcrowded, the Chemical Warfare Service of the Army found much needed research facilities at the Institute in the new Chemical Engineering Building, which was completely taken over by the C.W.S. Much important work was carried on here by army officers and civilian personnel working for the Army.

Submarines, airplane crews, hospitals, and welders need oxygen—in great quantities. Ordinary peacetime methods of production were not adequate, and consequently the war saw great advances in the efficiency of oxygen production and in transportation of oxygen in lightweight, portable units. Important contributions to these developments were made by Profs. Frederick G. Keyes and Samuel C. Collins, of the departments of Chemistry and Mechanical Engineering respectively.

Headed by Prof. Robert J. Van de Graaff of the Physics department, the High-Voltage Laboratory designed and built for the Navy five superhigh-voltage x-ray outfits for the examination of castings, and especially of munitions. Operating at potentials of several million volts, reliable and easily regulated, they represent a peak of achievement in securing penetrating x-ray pictures.

Under Prof. Robley D. Evans of the Physics department, the M.I.T. Cyclotron was operated on day-and-night shifts to produce radioactive tracer materials for a wide variety of war projects in metallurgy, medicine, and chemical warfare. Together with scientists from Harvard University and Massachusetts General Hospital, Prof. Evans and his staff made significant contributions to the development of methods for preserving whole blood and standardizing the product.

Throughout the war, the Wright Brothers Wind Tunnel was operated day and night in the testing of models of military aircraft in cooperation with the principal aircraft manufacturers. Many engineers were trained here for the design and operation of other wind tunnels, such as those for the Boeing Aircraft Company and the United Aircraft Corporation.

Among other important contributions to the war effort by the Institute's staff and laboratories are the development and evaluation of methods of long-range weather forecasting by the Meteorology department; general research on aircraft and automotive engines in the Sloan Laboratory; special missiles; silent weapons; surgical sutures; synthetic vitamins; synthetic rubber; flame throwers and incendiaries; testing of textiles for military and naval uses; testing of parachute cord; new alloys; military food processing and packaging; rations; optical materials; medicinal materials; new methods for extraction of metals from ores; emergency housing; explosives; applications of flash photography; camouflage; and fuses. The Institute's staff also did an enormous amount of technical consultation on various industrial problems connected directly or indirectly to war production and studied and handled labor relations for industry and government.

156 Huge Photographs Depict Operations Of Naval and Air Units In Pacific Theate

One hundred and fifty-six battle photographs of naval sea and air action in the Pacific theater are displayed along the first floor corridors as part of the "Victory In Science" show under the title, "Power in the Pacific."

Sponsored by the New York Museum of Modern Art this display consists of photographs which have been selected from hundreds of thousands of official Navy, Coast Guard, and Marine Corps pictures, and which have been expanded to form murals up to a size of six by eight feet. Selection was directed by Capt. Edward Steichen, USNR, director of the official Navy film "Fighting Lady." A brief introductory comment to the exhibit was written by Lt. Roark Bradford, USNR.

Although most of the photos were taken by enlisted men of the Navy, Coast Guard, and Marine Corps, some were taken by Capt. Steichen's unit of officer-photographers, and a number were snapped by automatic cameras in Navy planes attacking enemy planes and bombing enemy ships. Anonymous servicemen contributed other of the pictures. Since the names of some of the photographers could not b ascertained, no picture is credite to anyone by name.

Naval Operations Depicted

The exhibit depicts a naval oper tion in the Pacific theater, inclu ing practically every phase, su as life below a carrier deck, t rush to battle stations, a direct h on one of our carriers, a torpedo and sinking Japanese ship, and scenes of burial at sea.

A number of the pictures remarkable photographic sho One of the most outstanding picture of a flaming Jap car which seems to be only a hundred feet below the specta In another photo, a direct hit one of our carriers bursts ri into the camera, so close was shot. Another group of pictu were taken through the perisc of a submarine.

The exhibit begins with pictu of warriors and instruments destruction on a battleship. second sequence shows an a and the pilots' rush to man pla followed by a Jap attack. Next c the steps in an invasion, star with bombing by carrier planes subsequently by surface ships, followed by invasion and cap of Tarawa by the Marines. attack on the Jap fleet an counter-attack by the Japs is shown, after which come the tures taken from the subma Photographs of the return of pl and burial at sea conclude a operations.

EDITORIAL

(Continued from Page 2)

see what your bonds bought. By no means was *all* of the uipment exhibited here developed at M. I. T.; likewise, *all* the equipment developed at Technology is not on exhibit. e must realize, of course, that *Victory in Science* represents e fruit of the labor of scientists and engineers at many great merican and allied educational institutions and industrial labatories.

We take great pleasure in welcoming you to the Massachuts Institute of Technology. You've bought the bonds that de *Victory in Science* possible; you've got the right to be oud of what your bonds have accomplished.

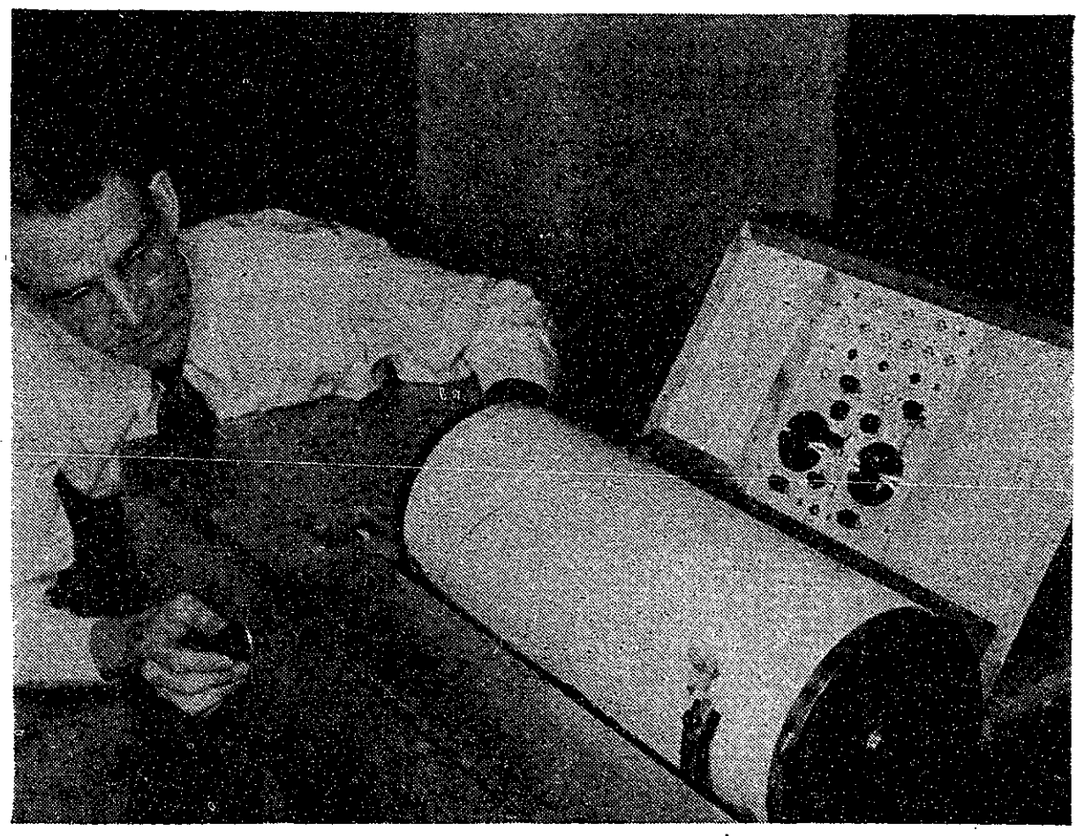
ramashop Members o Meet Wednesday

In order to make arrangeents for work to be done in e ensuing term, the M.I.T. ramashop will hold a meeting Wednesday, November 14, at 00 P.M. in room 2-178. The eeting is for old members ly, and they are all urged to tend. A smoker for new members is being planned for the ar future.

Greenberg To Conduct T.C.A. Chapel Tuesday

Rabbi Leonard A. Greenberg, Director of the Hillel Foundation at Simmons and Tufts Colleges, will lead the Second Chapel Service of the term, to be held on Tuesday, November 13, in the Emma Rogers Room (10-340) from 12:00 noon to 12:15 P. M. The Services are sponsored by the Technology Christian Association and are held weekly.

PLOTTING SHELL TRAJECTORIES



The 100-ton calculating giant, located at the Institute's Center of Analysis, which according to one expert, "computes the U. S. Navy's range tables in odd moments after five o'clock." Above, the machine draws curves representing shell trajectories.

Differential Analyzer

(Continued from Page 6)

of these shafts represent the changes in the values of the variables of the problem. It is not the rotational speed of the shafts, but their angular displacements relative to each other which are significant in this type of mechanized computing. The important elements of the differential analyzer are: (1) a group of mechanisms for performing the basic mathematical operations required; (2) a system for interconnecting the shafts of the mathematical units so that the operations demanded by the differential equation are performed and the equality expressed by the equation is satisfied and finally (3) a system for measuring and recording the angular displacements of these shafts as they rotate. By means of these units the machine is able to add, subtract, multiply, divide and integrate any variable with respect to any other variable.

A simple example of differential equation would be one which describes the distance traveled by an automobile in a given time. If the automobile travels 90 miles and its average speed is 30 miles per hour, it is a simple matter of arithmetic to find that it takes three hours to complete the journey. This is a problem involving a constant velocity or speed. However, it is quite probable that over a distance of 90 miles it would be impossible to maintain a constant speed of 30 miles an hour. There would be variations of speed due to hills, rough roads, curves, and traffic conditions. These variations might possibly occur in such a way that the total time required to travel the entire distance would still be just three hours and it could be said that the average speed was 30 miles an hour. However, if the driver tried to use this figure in computing how long it would take the car to reach some intermediate point on the journey, he would likely make a serious error. A differential equation takes into account the variations in instantaneous speed and by its solution the correct answer can be found for each instant.

In many problems of science and engineering the quantities, like the speed of a car, change continually. Such quantities are described as variables and calculus is the branch of mathematics employed to deal with them. With many types of variables, it is possible by means of calculus to obtain answers directly. However, in many other cases the methods which much be used are so slow and laborious as to be economically impractical. Thus a problem which would require the services of a group of specially trained computers for a period of weeks might be solved on the differential analyzer in a few minutes of hours.

In computing gun range tables the differential analyzer was given mathematical data obtained by firing a small number of experimental rounds and from this information the machine made computations plotting the velocity and trajectory of shells, as well as accuracy in firing at targets at any chosen distance. These computations made it possible to determine quickly the characteristics of guns and ammunition and compute accurate range tables without the expenditure of the enormous amount of time and money that would have been required to achieve the same results by complete firings covering all possible ranges.

Another interesting example of the complex type of differential equation this machine is capable of solving was the analysis of the complicated behavior of cosmic rays as they arrive from outer space and come under the influence of the earth's magnetic field. The problem was to determine and plot the effect of terrestrial magnetism on these mysterious messengers from outer space. When it is considered that the paths followed by the cosmic rays depend upon the intensity of the earth's magnetic field, including its variations with latitude and with distance from the earth, it will be recognized that cosmic ray phenomena involved in a complex form what mathematicians call "variables."

Hillel Foundation To Hear Shapiro At Meeting Friday

The Hillel Foundation will hold its first meeting of the term on Tuesday, November 13, at 5:00 P.M. in the Faculty Lounge. New students will be welcomed at that time. Howard V. Perlmutter, 2-46, president, will speak on the program planned for this term. A talk will also be presented by Judah J. Shapiro, director of the Foundation.

A weekly discussion series entitled "Contemporary Jewish Problems" will be inaugurated at the next meeting of the term, which will be held on Friday, November 16, at 5:05 P.M. in the Faculty Lounge. Mr. Shapiro will be the speaker.

3 J. P. Option Buyers Freed Of Redemptio

Drawing To Determi Ticket Winners; Sale To Resume Wednesd

Three people who purchase t Junior Prom options by Fri November 16 will receive the demption price of their tic free, according to an annou ment by Richard J. O'Donnell, chairman of the Junior Prom C mittee. The winners will be de mined by a drawing, the date which will be announced in next issue of **The Tech.**

Sales of options will be resu on Wednesday, November 14 will continue through Friday, vember 16 between 10:00 A.M. 2:00 P.M. in the Lobby of B ing 10. Options purchased thr the Bursar's office will be tributed at the desk in Buildi prior to the drawing.

The Junior Prom Weekend already scheduled, will last Friday, January 18 to Sunday, uary 20. The formal dance w held in the Imperial Ballroo the Hotel Statler on Friday January 18, while fraternity parties will follow on Sat night. All events of the J. P. end are open to the entire st body at Technology.