


LOBBY



by Mary Louise  
Goshay

LINES

The Royal Canadian Air Force represented by recent visitors: Marshall E. W. Stedman, Director General of Air Research, and J. H. Parkin of the National Research Council of Canada . . . John C. Evvard (Fuels & Lubes) receiving his Ph.D degree in absentia from the California Institute of Technology . . . A baby boy for the Donald R. Bellmans (F & L) and a girl for the G. Merritt Prestons (Wind Tunnel) . . .

Dorothy Ristow (Employment) returning to AERL from California, when her husband left for Florida for Officers' training . . . Those new pages stationed in the lobby to escort visitors and see that they don't wander . . .

J. M. Auerbach (Machine Shop) tiring of dairy farming, and creating quite a stir in his neighborhood when he loaded his cow into the back seat of a sedan for transporting to a farm . . . Margaret Poffenbarger (Employment) transferred from LMAL in May, resigning to be married when her Bombardier flew in from Pacific skies .

George J. Pack (Instrumentation) buying a one-way ticket to New York to report as Lieutenant in the Army . . . Ray Piorkowski, Apprentice, expediting purchase orders between offices during the recent rush, deciding he has all it takes to qualify for C. E. Burke's job (Assistant to the Manager) - i.e., he can sign his name!

Nominations for having the best cultivated Victory gardens: Esther Wagner (Fiscal), Thomas Dallas and Irving Pinkel (F & L), J. L. Sloop (Thermodynamics) and M. W. Hasenpflug (Stockroom) . . .

The westward migration of the Power Plants from Langley Field now complete, with the arrival of Chief Oscar Schey and his Supercharger contingent.

# TIPS

ERL, NACA.

August 25, 1945 No. 20

## RESEARCH SEMINAR

On August 9, the Engine Components Research Division, under the direction of the Division Chief, Mr. C.S. Moore, presented the fifth in a series of research seminars. Current projects upon which members of the Division are working were discussed.

A buffet supper, arrangements for which were made by Madeline Dornon, was served in the Auditorium to 90 members of the Laboratory staff by Miss Ruth Zimmer, Manager of the Cafeteria. Girls of the Division, Angela Haferd, Delphine Perlowski, Anne Bymakos, Helen Neiheiser, Florence Miller and Janette Sullivan acted as hostesses at the supper.

In the absence of Mr. A.M. Rothrock, Acting Executive Engineer, Mr. Moore conducted the meeting which began in the Foyer of the Auditorium

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## SEMINAR

*Continued from page one.*

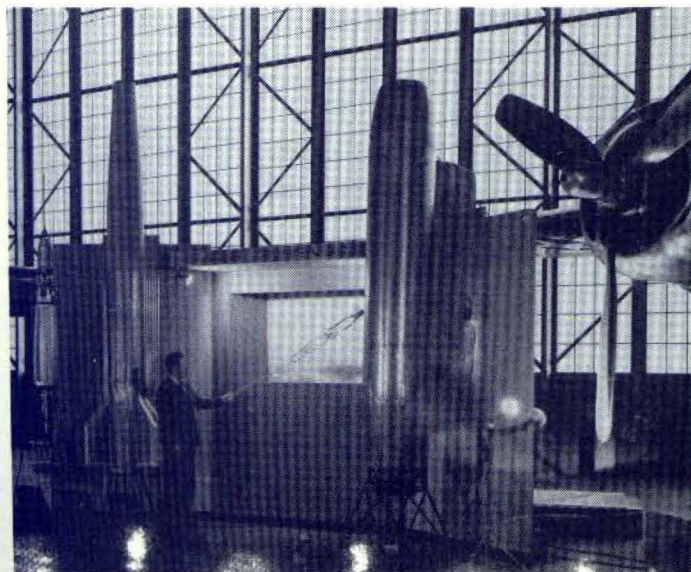
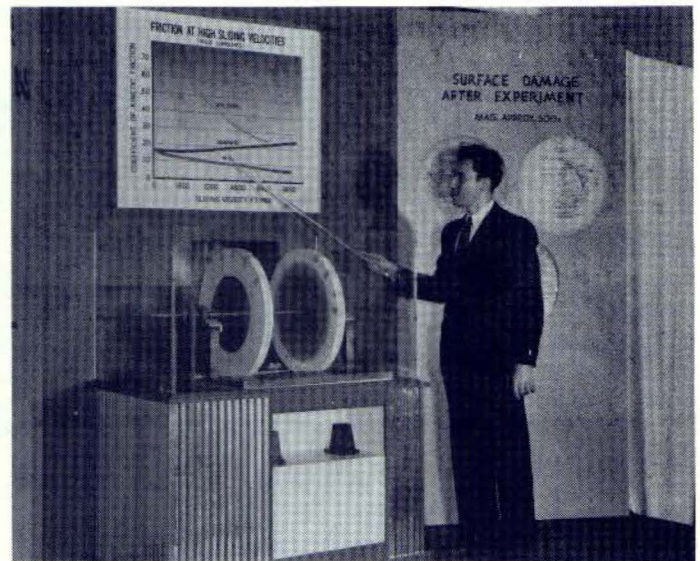
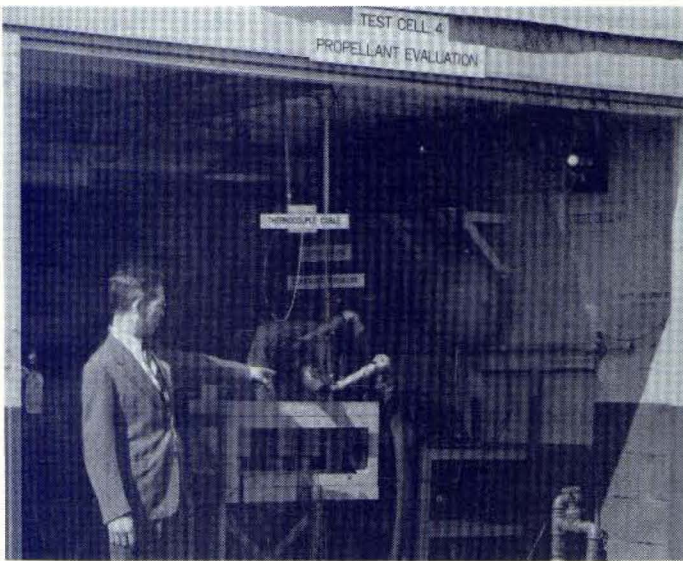
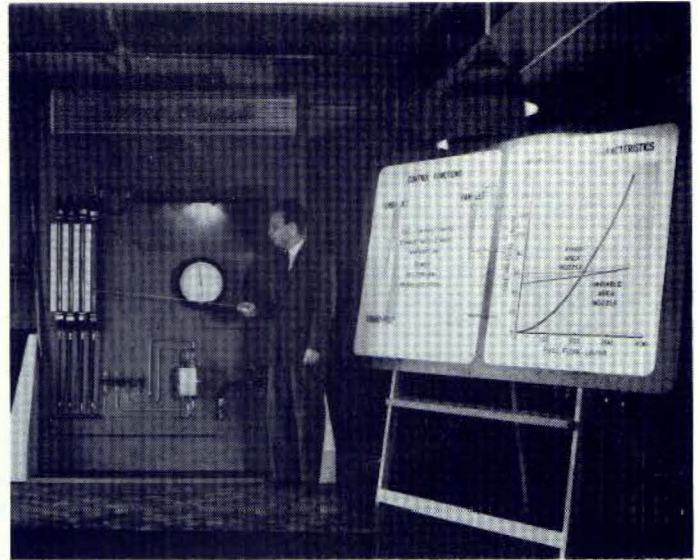
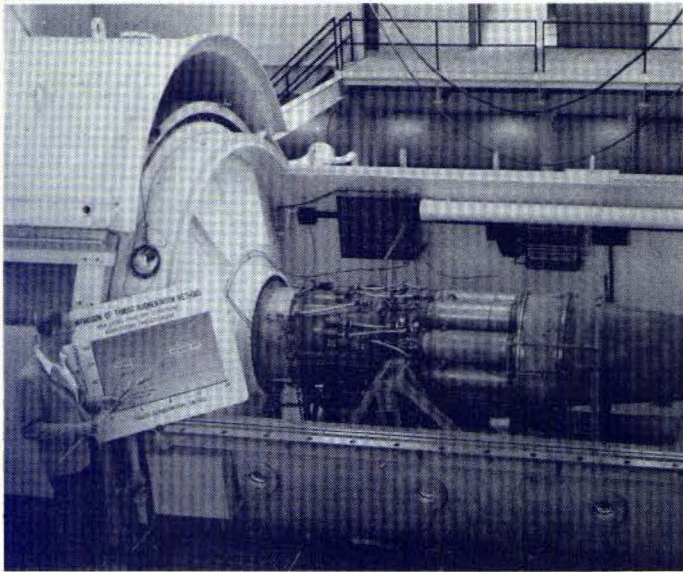
at 6:30 PM. Speakers were Sidney J. Shames, Charles S. Stone, John L. Sloop, Joseph R. Dietrich, Marcus F. Heidmann, Samuel S. Manson and Arthur G. Holms.

Profusely illustrated by slides, the talks were admirably presented by the speakers. A short discussion period followed each of the talks.

Arranged by the Executive Engineer's Office, these meetings serve to acquaint members of the research staff with the work of Divisions other than their own and also provide an opportunity for the speakers to gain experience in presenting a paper before an audience.

At the next seminar, the work of the Supercharger and Airflow Research Division will be discussed. Mr. O.W. Schey, the Division Chief, will make the arrangements.



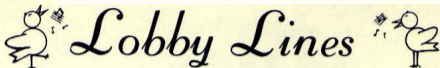


## DEMONSTRATIONS TYPIFY RESEARCH ACTIVITIES

Some of the exhibits on display at the First Annual Inspection, October 8, 9 and 10 and lecturers were: (1) Altitude Tanks, Bruce Lundin; (2) Controls Research, Harold Gold; (3) Rocket Lab, John Sloop; (4) Lubrication Friction & Wear Research, Ed Bisson; and (5) Flight Research, George F. Kinghorn.



WING TIPS, November 7, 1947



# Lobby Lines

John Sloop (F&T) and family recently had their house yanked out from under them -- and on two days' final notice. They lived in the area recently condemned for the new municipal airport. When the movers closed in on the Sloops, they made a hasty exit; John rushed out, bought a car, loaded up the family, and took them to North Carolina for a vacation. They are now waiting for the newly-located home to settle on its unfamiliar foundations before moving in. . .

# WIN



*Issued in the interest*

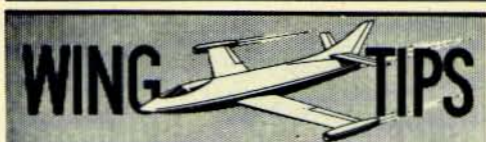
*Vol. VII* Sept 2, 1949

## F&T DIV. PRESENTS STAFF MEETING ON COMBUSTION, OCT.31

Current investigations on combustion problems were reviewed by members of the Combustion Branch, Fuels and Thermodynamics Division, at the research staff meeting in the auditorium Monday, October 31 at 8:00 p.m.

The following papers were presented: High Energy Fuels for Rocket Propulsion - John Sloop; Some Turbojet Combustor Problems - Howard Childs; Rocket Cooling - George Kinney; Flame Speed of Carbon Monoxide Air Mixtures Containing Either Heavy Water or Light Water - Glen McDonald; Effect of Temperature on Flame Speed of Propane Air Mixtures - Gordon Dugger; and Device for Measuring High Temperatures in Flowing Gases - Perry Blackshear.

The next meeting on Nov. 14 will deal with aircraft fire research. All research personnel are urged to attend as much relevant information will be presented and discussed.



WING TIPS is published at the Lewis Flight Propulsion Laboratory of the National Advisory Committee for Aeronautics, Cleveland 11, Ohio, in the interest of the employees. Contributions should be sent to the WING TIPS office, Room 100, Engine Research Building telephone, 3284.

Jane Eckert.....Editor  
 Cliff Haight.....Sports Editor  
 Frank Lalli.....Circulation Mgr.  
 NACA Employees.....Reporters

## AMES PILOT HONORED

William H. McAvoy, head of the Flight Operations Section at the Ames Laboratory and one of the oldest active test pilots in the United States, was honored on Jan. 21 on the completion of 30 years of service with the NACA.

During the ceremonies Dr. Smith J. DeFrance presented him with the diamond-studded lapel pin symbolic of the three decades he has devoted to furthering aeronautical research.

Mr. McAvoy, who learned to fly during World War I with the U.S. Air Service, has flown more than 100 types of aircraft of varying design, including flying boats, autogiros, gliders and conventional airplanes during his long career. (Con't. on P.4)

## PROFESSIONAL ACTIVITIES

A number of NACA scientists will read papers at the twenty-first annual meeting of the I.A.S. in New York City Jan. 26 - 29.

Abe Silverstein will act as chairman of the session on flight propulsion at which one of four papers scheduled is "Some Stall and Surge Phenomena in Axial-Flow Compressors" by Merle Huppert and William Benser (C&T).

At the session on rocket propulsion the first paper will be "The Effect of Fluid Properties on the Spray Formed by Two Impinging Jets" by Marcus Heidmann and Richard Priem (F&C).

Franklin Moore (Super.Prop.) will read his paper "Three-Dimensional Compressible Laminar Boundary-Layer Flow" at an aerodynamics session.

Rocket Branch Chief John Sloop has been named a Fellow of the American Rocket Society. Mr. Sloop began his career at the Langley Laboratory in 1941 and was later transferred here. He holds a Bachelor of Science degree in electrical engineering from the University of Michigan.

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## LOCAL A.R.S. FORMED

### BEN PINKEL IS FIRST SPEAKER

The first meeting of the Cleveland-Akron section of the American Rocket Society will have Benjamin Pinkel as speaker and will be held on March 26 in Tomlinson Hall on the Case Tech campus.

The local section has been organized through the efforts of Darryl Romick, Goodyear Aircraft Co., John Sloop, Rocket Branch Chief here, and Professor H. Burlage of the mechanical engineering department at Case. It is their aim that the society be of service and interest to men studying various types of power plants and that the membership not be confined to rocket researchers.

After Mr. Pinkel's talk on nuclear propulsion for aircraft scheduled for 8:00 p.m., an election of officers will be conducted.

Any Lewis men interested in joining this new group are urged to contact John Sloop or Paul Ordin at 2259.

The national society is guided by a board of directors composed of such illustrious scholars as Professor M.J. Zucrow, Purdue; Professor Martin Summerfield, Princeton; Mr. Kurt Berman, G.E.; C.C. Ross, Aerojet Engineering; and Raymond Young, Reaction Motors.

The local group intends to follow the tenets of the national organization which has among its lofty purposes (1) the encouragement of basic research and development, (2) the exchange of non-classified information on a broad basis, and (3) the coordination of engineering activities in the field of rockets and jet propulsion through technical committees on standards, nomenclature, etc., in a manner comparable to the ASME, SAE, and the IAS.

### SLOOP ADDRESSES AFA

John Sloop, Rocket Branch Chief, spoke before the Air Force Association at Hotel Hollenden on March 10 on the subject of rocket engines. He was introduced by Charles Tracey, Cleveland Press aviation editor.

### COURSE ON PATENTS OFFERED

Cleveland College is offering a short course on patents and inventions taught by Mr. Bruce B. Krost. The lectures will be given on Tuesday evenings from 7:00 to 9:00 p.m. for a period of eight weeks beginning April 7. The fee is \$15.

### ATTENTION GIRLS

Anyone interested in making a week-end retreat (in a group from the Lab) at St. Joseph's Retreat House, Lake Shore Blvd. at E.185 St., please contact Gertrude McNeeley at 2146.

SUBCOMMITTEE APPOINTMENTS

Appointments to the twenty-eight technical committees and subcommittees of the National Advisory Committee for Aeronautics, for the year 1954, have been completed. The following appointments have been made from the Lewis Flight Propulsion Laboratory of the NACA, at Cleveland, Ohio:

Reappointments:

Edmond E. Bisson  
 Subcommittee on Lubrication and Wear  
 Dr. John C. Evvard  
 Subcommittee on Fluid Mechanics  
 Dr. L. C. Gibbons  
 Subcommittee on Aircraft Fuels  
 Irving A. Johnson  
 Subcommittee on Compressors and Turbines  
 William Lewis  
 Subcommittee on Compressors and Turbines  
 Bruce T. Lundin  
 Subcommittee on Engine Performance and Operation  
 Eugene J. Manganiello  
 Committee on Operating Problems  
 Dr. Walter T. Olson  
 Subcommittee on Combustion  
 Benjamin Pinkel  
 Subcommittee on Heat Resisting Materials  
 I. Irving Pinkel  
 Subcommittee on Icing Problems  
 Subcommittee on Aircraft Fire Prevention  
 John C. Sanders  
 Subcommittee on Power Plant Controls  
 Newell D. Sanders  
 Special Subcommittee on Aircraft Noise  
 Abe Silverstein  
 Subcommittee on High-Speed Aerodynamics  
 Committee on Power Plants for Aircraft  
 John L. Sloop  
 Special Subcommittee on Rocket Engines  
 DeMarquis D. Wyatt  
 Subcommittee on Internal Flow

These men, who are serving their country in a personal and professional capacity without compensation, are selected because of their technical ability, experience, and leadership in a special field. They provide material assistance in the consideration of problems related to their technical fields, review research in progress both at NACA laboratories and in other organizations, recommend research projects to be undertaken, and assist in the coordination of research programs.

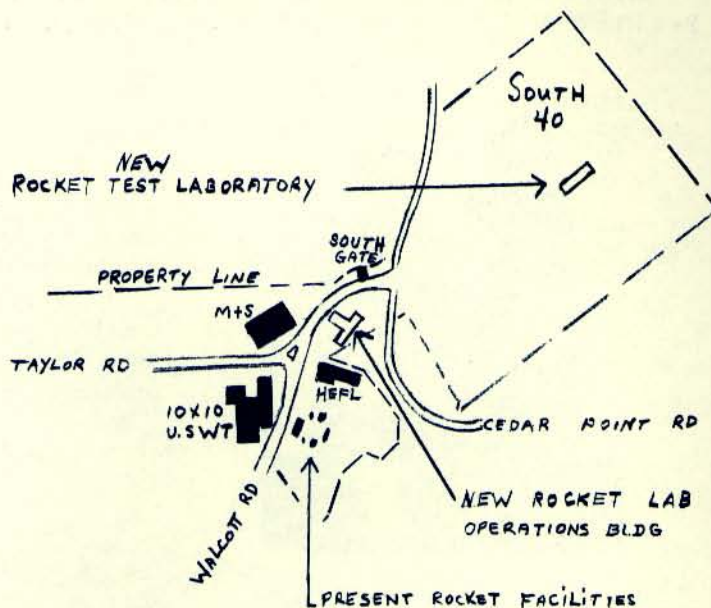
Dr. J. C. Hunsaker, Chairman of the NACA, said in connection with the work of the research agency during the past year, "Coordination of the many interests concerned with aeronautical research has been effectively accomplished with the NACA because of the interlocking character of the membership of its technical subcommittees."



## ROCKET LABORATORY

The ground has been broken for the new Rocket Laboratory Operations Building and test facilities. At the Operations Building, in its location across from M&S and near the South Gate, the cranes are busily lifting, shovels digging, contractors overseeing, and engineers consulting blueprints as the construction gets underway. This new building will contain offices, conference room, shop, an instrumentation center for recording and analyzing data, an instrument service room, and a control room for remote operation of facilities and research engines in the S-40 area.

Construction has also begun in the South 40 area (land belonging to Lewis Laboratory and located on the south side of Cedar Point Road). This area will contain a rocket test building which will be situated on the side of a 70 foot deep ravine. It will consist of an engine test cell, service area, high pressure propellant supply bays and an instrument terminal room. Other South 40 structures will include exhaust treatment equipment with a 400,000 gallon water reservoir and large steel treatment duct, propellant storage areas, and an electrical substation.



With the completion of this multi-million dollar facility, rocket research can be expanded greatly at Lewis. The facility will be used to study high energy rocket propellants and other problems related to long range vehicles. The estimated completion date for all facilities is December, 1956, and the present rocket facilities will continue being used after South 40 is completed.



Excavation in South 40.

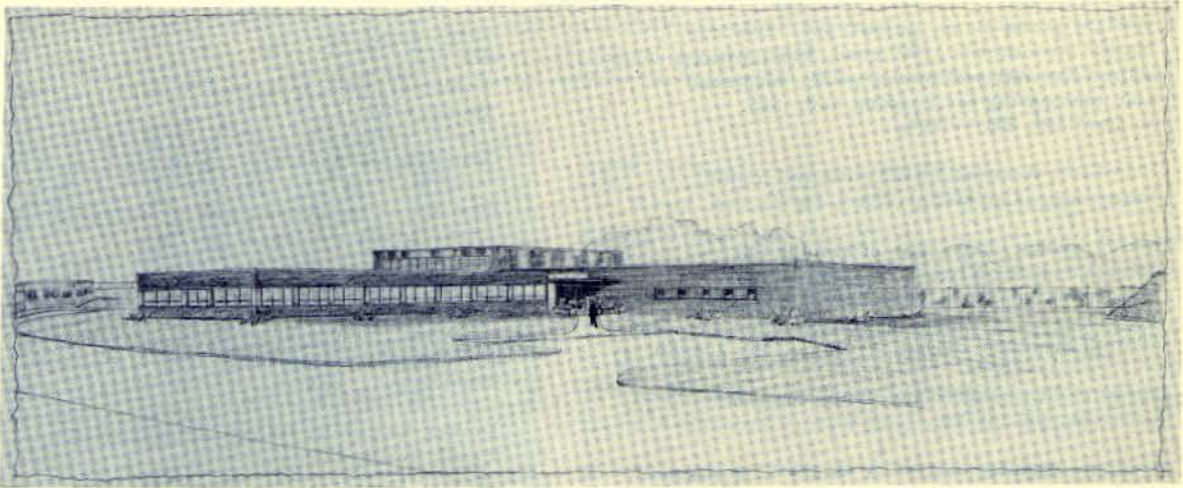


The T-shaped site of The Operations Bldg.



Project engineer for these new facilities is George Kinney and the assistant project engineers are William Anderson and Lou Rieman.

In our present Rocket Laboratory there are many active members in the Cleveland-Akron Section of the American Rocket Society, in fact, John L. Sloop, Chief of the Rocket Branch, is one of the co-founders of this local chapter. Other active participants in the Section's organization this year are Adelbert O. Tischler (Vice President), Gerald Morrell, Howard Douglass, William Tomazic, and Edward Rothenberg.



Architect's Drawing of Operations Building

Rocketry has gained much notice in the public eye recently concerning the NIKE Missile, the MOUSE (Minimum Orbital Unmanned Satellite of the Earth), rocket sleds and proposed rocket ships to outer space. So with the completion of the new Rocket Laboratory facilities Lewis Laboratory will be better equipped to keep 'out in front' in the field of rocket research.



The Rocketeers - Photo on left, L to R: H. Douglass, R. Priem, M. Heidmann, F. Salzano, H. Price, M. Lieberstein, C. Auble, W. Tomazic, D. Nored, J. Sloop. Photo on right, L to R: Back row; I. Pass, G. Morrell, C. Feiler, G. Kinney, J. Rollbuhler, A. Tischler, E. Krawczonek. Front row; L. Baker, J. Bahan, E. Rothenberg, C. Bibbo, F. Kutina, D. Ladanyi.



November 11, 1955

WING TIPS, an official publication of the Lewis Flight Propulsion Laboratory, National Advisory Committee for Aeronautics, Cleveland 11, Ohio, is published bi-weekly in the interest of Lewis employees. Send contributions to the Editor, 104 ERB, telephone 3284. Deadline: Monday after pay day.

Editor.....Marjorie Hyre

Reporters.....NACA Employees

NACA "Rocketeers" Participate In ARS Annual Meeting - November 13-16, 1955, the American Rocket Society will hold its 25th Anniversary meeting in Chicago. Mr. John L. Sloop, Rocket Branch Head will preside as Chairman of the Liquid Propellants Symposium. Mr. Marcus F. Heidmann(Rocket Lab) will present a paper "Rocket Performance Measurements with Streak Photography" authored by Mr. Heidmann and Carmon M. Auble.

85 YEARS MERITORIOUS SERVICE REPRESENTED IN RECENT AWARDS

Benjamin Pinkel, Chief of M & T division, was awarded his 25 year service pin last week. A native New Yorker, Mr. Pinkel received his B.S. degree in Electrical Engineering from the University of Pennsylvania. He joined the NACA at Langley February 2, 1931, transferring to Cleveland in December, 1942.

When Mr. Pinkel came to the NACA in 1931, it was believed that the Diesel engine, because of its high efficiency, was the aircraft engine of the future. His first assignment was the design of components for a Diesel test engine. The Diesel engine passed out of the picture in about 1936 and he saw the interest of the laboratory change progressively to the spark ignition engine, the turbine engines, the ramjet, the rocket, and the nuclear propulsion systems. During that time the laboratory grew from a staff of 250 to 7000 personnel.

Among his many activities Mr. Pinkel is a member of ASME and an Associate Fellow of IAS. He is listed in both Who's Who in Aviation and Who's Who in Engineering .



Receiving his 15 year pin was John L. Sloop, Chief of the Rocket Branch. A graduate of the University of Michigan with a B.S. degree in Electrical Engineering, he joined the NACA at Langley February, 1942, transferring to Cleveland in December, 1942.

An active member of the ARS, he is past President of the Cleveland-Akron section. He is also a member of the Subcommittee on Rocket Engines and a member of the American Standards Association Subcommittee on Rocket Symbols. In his local activities Mr. Sloop is on the Neighborhood Commission for the Boy Scouts of America.



J. Cary Nettles also received his 15 year pin last week. A native southerner from Arkansas, he earned his B.S. degree in Electrical Engineering from Louisiana State University. Entering on duty at Langley in February 1941, Mr. Nettles transferred to Cleveland in December 1943. He is presently Assistant Chief of 8x6 Branch, the Supersonic Propulsions Division.

An enthusiastic radio "Ham" operator, Mr. Nettles is a charter member and past President of the West Park Radiops and serves in communications with the Civil Defense.



John W. R. Creagh, Aeronautical Research Scientist in Compressor and Turbine Division, joined the NACA at Langley February 14, 1941. Hailing from Salamanca, New York, he received his B.S. degree in Electrical Engineering from the University of Illinois. Mr. Creagh, last week receiving his 15 year pin, transferred to Cleveland in 1943.

A great advocate of the Do-It-Yourself philosophy, especially with the wood saw, he completely finished the upstairs of his home and is currently building a doll house for his daughter.



Another who received his 15 year Meritorious Service Award was Harvard O. Fry of Facilities Engineering Division. A native of Milwaukee, Wisconsin, he attended Ohio State University and is presently engaged in architectural work for the Lewis Laboratory. Mr. Fry joined the NACA at Langley February 4, 1941, transferring To Cleveland December 12, 1941.





## WITH OUR SPEAKERS



Requests are numerous for Lewis scientists and engineers to speak before groups in Greater Cleveland and surrounding areas. The month of January has been a busy one for the following men who have lectured on various aspects of NACA research.



John Sloop (Rocket Engines) and Matt Portz (Information Specialist) presented a half-hour discussion over radio station WPVL Painesville on the 5th. Mr. Sloop also spoke before the Pesco Products executives on the 18th, while Mr. Portz was guest speaker at the Brooklyn Exchange Club meeting on the 9th and before the St. Paul's Men's Club of Berea on the 23rd. . . . George Deutsch (Reactor Materials) spoke to the American Society of Tool Engineers in Elyria on the 8th. . . On the 9th, Elmer Buller (Flight Measurements) addressed the Cleveland Junior Chamber of Commerce . . . Willson H. Hunter (Assistant to the Director) was guest speaker at the American Society of Mechanical Engineers meeting on the 9th and at the Norwalk, Ohio Kiwanis meeting on the 16th. . . . J. Carey Nettles (3x6 Supersonic Tunnel) spoke to the Lorain Presbyterian Church Men's Club on the 14th. . . .

Scott Simpkinson (Flight Measurements) addressed the American Institute of Electrical Engineers on the 14th . . . Guest speaker before the Cleveland Junior League on the 15th was Paul Ordin (Flow Systems). . . W. V. (Eb) Gough (Flight Operations) addressed the Bedford Ground Corps Observers group on the 17th . . . Also on the 17th, Calvin Weiss (Training Office) spoke to the Lyndhurst YMCA members. Mr. Weiss addressed the Men's Club of the Methodist Church on the 21st. . . Robert Kohl (Systems Performance) spoke before the members of the Ridgeville Congregational Church on the 19th. . . Guest speaker before the Cleveland Engineering Society on the 28th was Dr. Melvin Gerstein (Propulsion Chemistry) . . . Jack C. Humphry (Rocket Engines) will speak to the Fenn College SAE section tonight, Jan. 29th . . . A. O. Tischler (Rocket Combustion) will address the Lakewood Hospital Staff this evening the 29th.

## TRANSFER TO HEADQUARTERS

Three members of the Lewis staff are in the process of transferring to new assignments and quarters at the NASA headquarters in Washington, D.C.

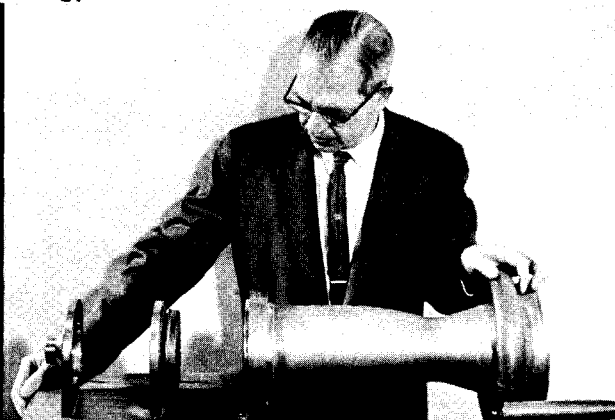
Now with the Office of Space Flight Programs is William A. Fleming, formerly Assistant Chief of the Propulsion Aerodynamics Division. Bill is a long-time Lewis man, having joined the staff in August, 1943, shortly after receiving his B.S. degree in Aeronautical Engineering from Purdue University.

John L. Sloop, Chief of Rocket Systems Branch, also transfers to the Office of Space Flight Programs. John received his B.S. degree in Electrical Engineering from the University of Michigan in 1939, joining the NACA staff at Langley in 1941. He transferred to Cleveland in 1943 to what is now Lewis Research Center.

Fred D. Kochendorfer is the third of the triumverate to transfer to Washington where he will work in the Advanced Technology Program. Fred is also a well-grounded NASA man, having joined the Lewis staff in 1943. He received his B.S. degree in 1943 from Stevens Institute of Technology.



William A. Fleming & Fred D. Kochendorfer



John L. Sloop



ORBIT, an official publication of the Lewis Research Center, National Aeronautics and Space Administration, Cleveland 35, Ohio is published bi-weekly in the interest of Lewis employees. Send contributions to the Editor, Room 5, Administration Building.

Editor . . . . . Marjorie A. Hyre

Deadline: Friday after pay day.

Reporters . . . . . NASA Employees

## FAREWELL PARTY FOR SLOOPS

John and Atlasse Sloop seem to agree with Dr. Sharp's recommendations for happy living in Washington, D.C., as they were photographed at the farewell party for the Sloop's on April 24. John has transferred to the Office of Space Flight Programs at NASA Headquarters. With Lewis for seventeen years, he held the position of Chief of Rocket Systems Branch.



# **AIAA To Meet Oct. 21; John L. Sloop Is Speaker**

John L. Sloop, Assistant Associate Administrator, Office of Advanced Research and Technology, NASA Headquarters, will be the speaker at the next meeting of the Cleveland-Akron Section of the American Institute of Aeronautics and Astronautics.

The meeting is scheduled for Thursday, October 21, at the Cleveland Engineering and Scientific Center, 3100 Chester Avenue. Social hour at 6 p.m.; dinner at 7; meeting at 8.

Sloop will present the 1965 Theodore Von Karman Lecture of the AIAA. It is entitled "New Horizons in Aeronautics."

The lecture was originally delivered on July 27 by Dr. Raymond L. Bisplinghoff, who was selected by AIAA for its Von Karman Lecture honors this year.



# *Several staffers featured in 'bestseller' on Lewis*

"Liquid Hydrogen as a Propulsion Fuel, 1945-1959" by John L. Sloop, NASA SP-4404, U.S. Supt. of Documents, 1978, 325 p.

Lewis Research Center's staff members are the heroes of a bestseller, "Liquid Hydrogen as a Propulsion Fuel, 1945-1959." This book is the closest to a history of the Center that has yet been written. Over 50 Lewis researchers are mentioned and quoted and described as John Sloop, the author and

a former Lewis staffer (1942-1960), traces the development of liquid hydrogen as a fuel in aircraft and rockets.

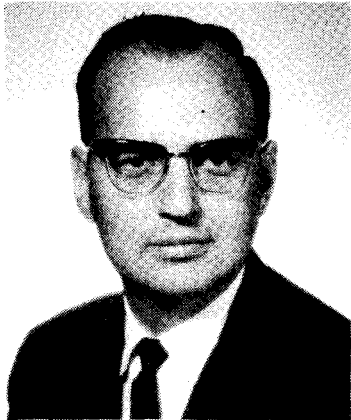
The author first covers the Air Force interest in liquid hydrogen and their support of Herrick L. Johnston's Cryogenic Laboratory at Ohio State University in 1942. He also reviews the Navy's Bureau of Aeronautics interest in 1945 in liquid hydrogen as a fuel for a

*(Continued on page 3)*

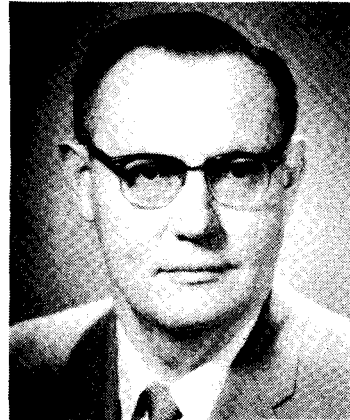
Lewis News: May 11, 1979

# Staffers in 'bestseller'...

*(Continued from page 1)*



Edward F. Baehr



Glen Hennings



Dr. Seymour C. Himmel



Dr. Walter T. Olson



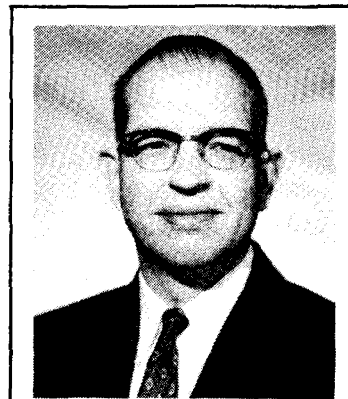
Richard J. Weber

single-stage rocket to boost a satellite into orbit.

Much of this provides illuminating insights and background into NACA's and specifically, Lewis' involvement with and significant contributions to research on high energy propellants, research on hydrogen for high altitude aircraft, and work with propellants to develop the capability of rockets to launch satellites

and space probes.

John Sloop, the author, retired from NASA Headquarters in 1972 after 31 years of aeronautical and space research and management with NACA/NASA. He came to Lewis in 1942 and was made head of the laboratory's rocket research in 1942 and this group published over 150 reports on high energy propellants, ignition, combustion and cool-



John L. Sloop,  
Author of the 'best seller'

ing. A thoroughly knowledgeable expert in his field, Sloop presents an informative story and sprinkles it with anecdotes about his Lewis lifetime.

For example, he notes that Lewis was completely reorganized in 1945 to reflect the shift of emphasis on research from piston engines to jet engines (turbojet and ramjet) with some work on rockets. The rocket work was kept small because of the conservative nature of NASA...and the work "rock-er" was avoided in the organizational name in favor of "high pressure combustion."

He also paints a candid but warm portrait of Abe Silverstein as a director of the center and space program leader. And there are revealing descriptions of Bruce Lundin's and Walter T. Olson's strong input for NASA to "move boldly into the space program," at meetings held in late 1957.

This is a well-written, fascinating story about the history of liquid hydrogen as a fuel. But, for Lewis staffers in particular, it is a warm return to memories filled with challenge and achievement. Paperback copies may be ordered from the Center Bookstore.





# Lewis News

One Small Step For Man, One Giant Leap For Mankind

## Apollo 11 – 20th Anniversary Of First Lunar Landing

Twenty years after the first manned landing on the Moon, President Kennedy's commitment to the lunar mission sounds as bold as it ever did. American astronauts would fly a quarter of a million miles, make a pinpoint landing on a strange planet, blast off it, and return home safely after an eight-day voyage through space. When Kennedy challenged the nation to risk this incredible journey, the only United States manned spaceflight up to that time had been Alan B. Shepard's 15-minute suborbital excursion in Mercury capsule Freedom 7. NASA was not exactly sure how the lunar mission should be made at all, let alone achieved in less than 10 years' time.

Answering President Kennedy's challenge and landing men on the Moon by 1969 required the most sudden burst of technological creativity, and the largest commitment of resources (\$24 billion), ever made by any nation in peacetime. At its peak, the Apollo program employed 400,000 Americans and required the support of over 20,000 industrial firms and universities.

It took a decade to send Apollo 11 astronauts Neil Armstrong, commander; Michael Collins, command module pilot; and Edwin "Buzz" Aldrin, lunar module pilot, to the Moon. But on July 20, 1969, when Armstrong and Aldrin climbed out of the Eagle and stood on the Moon's surface, in the Sea of Tranquility, the time, the effort, the cost, and the risks were worth every long hour worked, every frustration, and every penny. The whole country swelled with pride when our flag was planted on the Moon's surface.

### Lewis' Contribution To The Apollo Program

Lewis provided important early research, as well as subsequent direct technical support to the Apollo program. The center's contributions included pioneering research in rocket tests with liquid hydrogen and liquid oxygen systems; engineering studies of tanks, lines, and liquifiers for liquid hydrogen; wind tunnel tests of Saturn vehicles and of the Launch Escape Subsystem; studies in the Zero Gravity Research Facility for settling propellants in fuel tanks; and technical consultation and advice in such areas as safety, fuel cell performance, rocket engine combustion, propellant pump design, and thrust chamber fabrication.

Among the shapers of history in the early years of the space program was Lewis' past director Dr. Abe Silverstein (1961-69). In 1958, when he was Associate Director of Lewis, Dr. Silverstein was called to Washington to help organize NASA, which was, as the successor of the National Advisory Committee for Aeronautics (NACA), to be the nation's civilian agency for meeting the challenge of space. Dr. Silverstein took with him several key Lewis employees, including George Low, Elden Hall, Del Tischler, John Disher and John Sloop.

Within the new agency, Dr. Silverstein was appointed the Headquarters Director of Space Flight Programs with responsibility for developing and initiating all space missions. Among the many missions conceived at that time was a manned journey to the Moon and back. Dr. Silverstein gave the program the name "Apollo." He chose the name after pursuing a book of mythology at home one evening, early in 1960. He thought that the image of "Apollo riding his chariot across the Sun was appropriate to the grand scale of the proposed program."

### Liquid Hydrogen-Oxygen Propellants

Between 1959 and 1961, Dr. Silverstein chaired the committee that determined the characteristics of the Saturn family of launch vehicles, including the use of liquid hydrogen-oxygen propellants. Long before Apollo was ever planned or named, Lewis was advancing the propulsion technology which would help make the mission possible.

As early as the later part of the 1940s, Lewis had begun research on high energy liquid rocket propellants under the direction of Dr. Walter T. Olson, and by 1952, this work included studies of liquid hydrogen-liquid oxygen.

Initial Lewis investigations used very small thrust chambers in the range of 100 to 1,000-lbs. thrust. Over the course of the next decade, rocket engineers and scientists experimented with a variety of thrust chamber designs to achieve high combustion efficiency and smooth burning; and they measured heat transfer rates within the thrust chamber and demonstrated how to cool the chamber and nozzle with liquid hydrogen.

By 1958, as the United States entered the space business, Lewis had tested a fully-cooled, liquid hydrogen-liquid

oxygen thrust chamber at what was then the large scale of 20,000 lbs. thrust.

The experience Lewis propulsion experts gained in the field of high energy propellants later led to the development of the 15,000 lb. liquid hydrogen-liquid oxygen engine designated RL-10. Two of these engines power the upper stage of the Atlas-Centaur launch vehicle that had been under Lewis management since 1962. (Atlas-Centaur launched the Surveyor spacecraft that landed on the Moon, and the Mariner spacecraft that flew by Mars on July 31 and August 5, 1969).

Much of the same technology developed by Lewis for Centaur was particularly applicable to the J-2 liquid hydrogen-oxygen engines of the Saturn second stage (S-II).

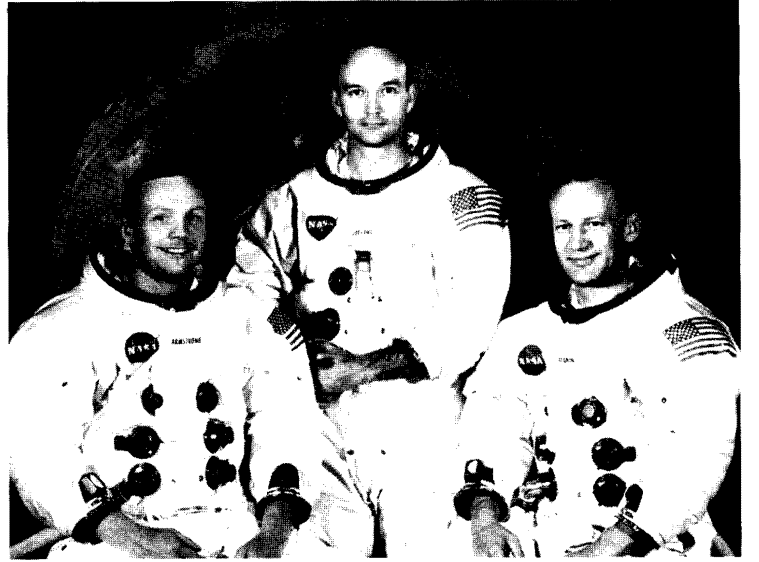
Consequently a number of Lewis staff members — men by then well experienced in high energy propulsion systems — were called upon by Headquarters to serve on the technical assessment teams which recommended the contractor to build the F-1 and J-2 engines. Dr. Silverstein chaired the Source Board which made the final selection of the F-1 contractor. Work began on the F-1 engine, the nation's largest, in 1958 and on the J-2 in 1960.

### Consulting With Marshall

During the course of development of these engines, Lewis continued its technical support in the form of consultation with Marshall. Melvin Hartmann, now director of University Programs, and Ambrose Ginsburg, both fluid systems engineers, served on a Marshall committee to review problems being experienced by the F-1 turbopump.

These and other specialists served as consultants on a J-2 review committee. Among the topics discussed, and of particular interest to the Lewis men, was the inducer, that component which draws the boiling cold hydrogen into the pumps. Previous research conducted on this component at Lewis' Plum Brook Station helped verify data of the Marshall Center that showed the inducers would permit a desired low pressure in the fuel tank.

Lewis also assisted a Marshall task group in achieving combustion stability in the F-1 engine. Dr. Richard Priem, experienced in advanced rocket combustion, was one of this group studying "rocket screaming," a phenomenon



Apollo 11 crew, left to right, Neil A. Armstrong, commander; Michael Collins, command module pilot; and Edwin E. "Buzz" Aldrin, Jr., lunar module pilot. NASA photo.

caused by strong resonant pressure waves which can destroy a rocket engine in seconds.

### Zero-G

The center's unique Zero-Gravity Facility was called upon to do two jobs for the Apollo program. In mid-1960, engineers used this facility to help solve the problem of restarting the Service Module's propulsion system in space. Using surface tension phenomena observed during these studies, Lewis engineers assisted in designing a retainer for the propellant at the bottom of the tank to ensure that propellant would enter the pump and restart the engine.

### Consultations

One of the astronaut's concerns about how weightlessness in space might affect fuel cell performance drew helpful information from Lewis too. Fuel cells are carried aboard the Service Module to provide electric power to spacecraft systems. Consequently, Lewis researchers investigated this area and made known to the Manned Spacecraft Center (now Lyndon B. Johnson Space Center) that the condenser of the fuel cell did not depend on gravity to operate properly. Lewis also was asked by the Manned Spacecraft Center to determine the heat transfer characteristics of the condenser; this information was used in a computer simulation of the spacecraft's electrical power subsystem.

During 1967, Lewis engineers were consulting on the overall combustion and system stability of the Lunar Module ascent engine, the critical propulsion system for the Ascent Stage which returns the astronauts from the Moon to lunar orbit.

The center's 8 by 6-foot transonic and 10 by 10-foot supersonic wind tunnels were used in extensive tests on models of Saturn booster stages. The first tests were made in the late 1950s when engineers studied base flow and heating tests on the SIB

booster, the eight-engine first stage of the Saturn I. The 1/45th scale model had real, working rocket engines of 250 lbs. thrust each. Data were taken over a range of speeds from takeoff to Mach 3.5 and of altitudes from sea level to 150,000 feet. This simulation of actual flight conditions provided valuable information on the pressure and heat loads experienced on the base and engines' compartment of the SI vehicle. By varying the size and location of flow detectors and shroud air scoops — devices to channel the air to best advantage — engineers were able to minimize the pressure and heating loads. Another study on the SI helped optimize vehicle flight stability and air pressure distribution.

In the 1964-66 period, base flow and heating also were studied in both wind tunnels for the SI C first stage of the Saturn V. Also, the force required to move the engine nozzles for directional control had to be measured. These measurements helped determine the size of the actuators required to gimbal the engines.

### Safety

In all manned missions, safety of the public, the astronauts, and the operating crew is a major concern to NASA. In case a mission must be terminated early, one of the first options the astronauts have is to employ the Launch Escape Vehicle and Tower, which stands atop the Command Module. This escape system propels the Command Module out and away from the Saturn V. During 1964, tests were made on the system in Lewis' 8 by 6 tunnel at the request of the Manned Spacecraft Center. In the tunnel, a model of the escape system attached to the Command Module was released at various angles to determine its stability under simulated flight conditions.

Safety was the subject that brought I. Irving Pinkel, formerly Lewis' assistant director for Aerospace Safety, to serve as a consultant to the Apollo

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