ENGINEERING AND SCIENCE

MONTHLY

JANUARY 1948

PUBLISHED BY CALIFORNIA INSTITUTE OF TECHNOLOGY ALUMNI ASSOCIATION

BY-LINES

RODERICK K. CLAYTON

Roderick K. Clayton was born in Tallinn, Estonia, and came to Chicago in 1929 at the age of seven. In 1935 he moved to Pasadena, entering C.I.T. in 1939 in the chemistry option. Joining the Army Air Forces in 1942, he served as an instrument flying instructor for one year, then flew 14 missions in B-29's from Guam. In 1946 Clayton returned to C.I.T. He graduated in June 1947 as a physics major, and is working for an M.S. in physics this year. Clayton is a first lieutenant in the Army Air Corps Reserve.

COVER CAPTION

The 200-inch mirror going through the junction town of San Juan Capistrano on its way to Palomar Mountain. The San Juan Capistrano Mission, noted for its part in California's history and for its present swallow population, is seen in the background.

ENGINEERING AND SCIENCE MONTHLY is published monthly, October through July, by the Alumni Association, California Institute of Technology, Inc., 1201 East California Street, Pasadena 4, California. Annual subscription $3.50, single copies 35 cents. Entered as second class matter at the Post Office at Pasadena, California, on September 6, 1939, under the act of March 3, 1879.

ENGINEERING AND SCIENCE
Monthly
The Truth Shall Make You Free

CONTENTS FOR JANUARY 1948

ENGINEERING AND SCIENCE MONTHLY

Published at the California Institute of Technology

Member of the American Alumni Council

The Main Line

JANUARY, 1948

With a glow of parental pride—and justifiable pride, we feel—we announce a date of some import in the history of the Golden State Route:

January 4, 1948: birthday of the NEW *Golden State*—a streamlined, truly smooth-riding, de luxe train—speeding cross-country, Los Angeles to Chicago, in just 45 luxurious, pleasure-filled hours.

That NEW goes in capitals because this train is multiply new: new in equipment...new in ride-comfort... new in schedule.

Handsome is the word for our new equipment: diners and coffee-shop lounge cars with decorations inspired by the handicrafts and rich colorings of the Southwest and Mexico... finest, lightweight Pullman sleeping cars, with complete choice of accommodations; reserved-seat reclining chair cars...new diesel locomotives that pack phenomenal power under brilliant red-and-silver exteriors.

Luxurious and comfortable are a couple more words for the NEW *Golden State*—and apply whether it's sitting still or hustling cross-country. The Golden State Route is the low-altitude route, and the roadbed is engineered for speed with comfort. The result: a superlative, smooth-gliding ride.

That new schedule also calls for a word (or two) of approval. It combines a convenient, noontime (12:30 p.m.) daily departure from Los Angeles with an equally handy second-morning-following (11:30 a.m.) Chicago arrival. And, what's more, there's through Pullman service to New York—no change of cars—and a St. Louis Pullman, too. And if your destination is anywhere else in the East or Midwest, take a look at a Chicago time table and see how many *Golden State*-connected trains there are to get you out of Chicago in a hurry—if you want to get out of Chicago in a hurry.

In other words—we really think we've got a train in the NEW *Golden State*. And we think *you'll* think so, too—once you've traveled on her. So, if there's a trip East in your future, be sure to see your near-by Southern Pacific Agent about reservations on the NEW *Golden State*.

Speaking of birthdays, here's another date of note: January 8, 1863—85 years ago this month. On that day the first shovelful of dirt was turned on construction of the old Central Pacific.

We've come a long way at Southern Pacific since then. When those four founding fathers—Huntington, Stanford, Crocker and Hopkins—started out, they had a railroad 31 miles long. Today, Southern Pacific—giant of the West, and one of the nation's three biggest railroads—has 15,379.65 miles of road in operation. And—according to our demon statistician, Lorenzo, who is a fanatic for preciseness—that includes Pacific Electric operation in Southern California, the S.P. de Mexico, the Tecate & Tijuana, and other subsidiaries!

(Another S.P. feature—a unique one: Southern Pacific is the one railroad with a choice of four routes from the Pacific Coast East: the Golden State, Los Angeles-Chicago; the Sunset, Los Angeles-New Orleans; the Overland, San Francisco-Chicago; and the Cascade, via the Evergreen Pacific Northwest. Next time you round-trip East, plan to go via one S.P. route, return via another—see twice as much en route. Let your near-by Southern Pacific Agent help you with an itinerary. No obligation, of course.)

S·P the friendly Southern Pacific

Index to Advertisers

• • •

Letters

A propos the October 1947 ENGINEERING & SCIENCE cover showing a graph of pressure variation in a high-pressure gas line) . . .I hope I won't be the only one to write and say that the paper ran through the machine backwards. Incidentally, it will result in a commercial plug, but I am curious as to what type of a recorder it was; that is, who made it.

Now as to what the reader thinks of the magazine, well I think it fits the school—not large, not padded, that is, but containing articles that are technically interesting and informative enough to make it worth the time it takes to scan the index. The C.I.T. News keeps us posted . . .

Pat J. Harney
Chicago, Ill.

Several comments were received on the cover of the October issue. The engraver made the color plate backward, and it slipped by. The machine was a Brush direct-inking, oscillating recorder with a home-made pickup, adapted from a standard Brush detonation pickup by Lane Wells Company, Los Angeles . . . Ed.

With the Editor--

THANKS are due to several of you for your letters of criticism and suggestion; we appreciate receiving your letters even if they can't be 100 per cent complimentary.

One thing that a number of you have suggested is that use be made of **Engineering & Science** pages by the Placement Bureau to tell alumni of job openings. We should like to report that we are working on this suggestion and have the agreement of Wendell Miller, director in charge of placement activities, that his committee will endeavor to work out a means of telling you of job opportunities and something of the placement work in our pages. The chief problem at present is the time factor in publishing **E&S.** Deadline for rough copy is 10 days before the first of the month preceding publication, and we have a schedule worked out that will get E&S in the mail on the 24th of that month. This seems a long time, but we can't give the printer a rush job every month, and proof reading takes time. We have also allowed time for such emergencies as illness and a slowdown strike in the bindery—this happened to us last month.

All of which gets us back to the fact that if a job is open at copy deadline time, it is usually filled by the time E&S is mailed out. However we are working on a special deadline date for placement copy, and hope to have such a department set up in a month or two.

* * * * *

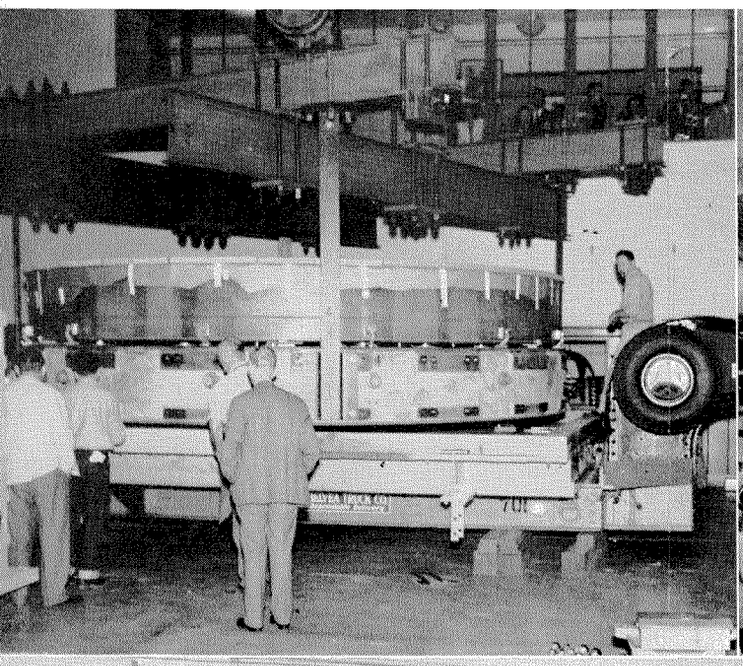
George Hall, in charge of the Institute public relations work, did a fine job in getting publicity of the right kind in connection with the recent move of the 200-inch mirror from the campus to Palomar Mountain. We saw George the night before the move was to begin. He had to be on the campus at 3 the next morning and he was a little anxious lest the news leak out and a crowd assemble to be in the way of the movers. All went well, however, and Hall was able to relax after the move for the first time in weeks. George thanks the press heartily for the fine cooperation which brought this publicity job to successful completion.

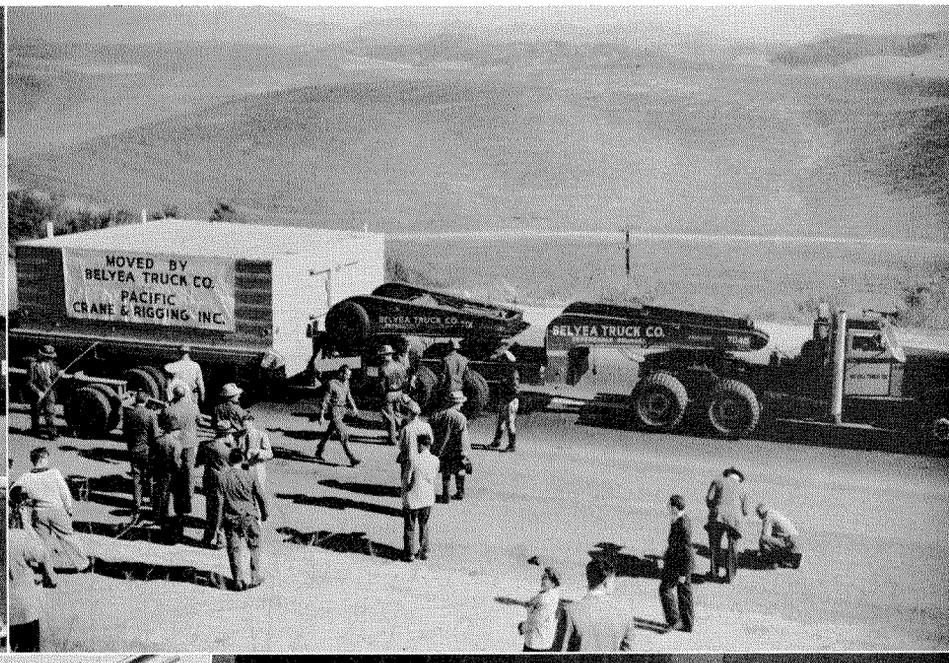
George Hall is one of the most energetic and willing fellows we have known, and he is helping us of the E&S staff a great deal.

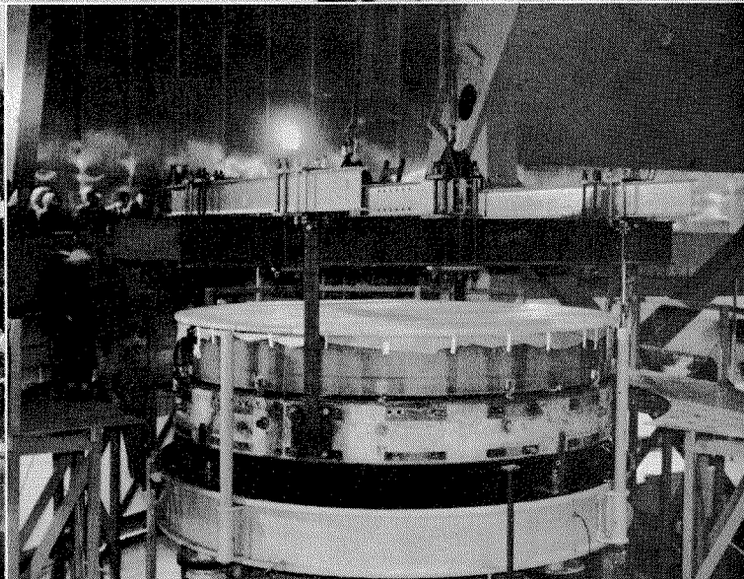
* * * * *

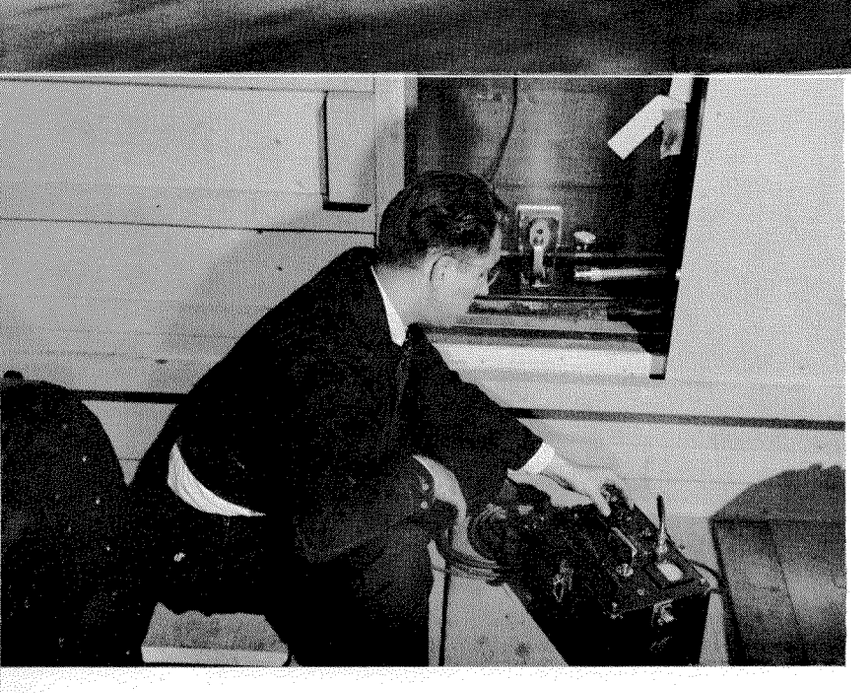
Writing of Palomar reminds us that we plan to have some special issues this year; geology in February and astrophysics in June. Dick Jahns '35, associate professor, and Dr. Chester Stock, chairman of Geology, are cooking up some interesting articles on the work of that division. Dr. Stock will be remembered for his many contributions to these pages, the most recent of which appeared last April.

Our astrophysics issue will tell the story of Palomar. If the budget permits us to be as comprehensive in our coverage as we plan, this should be an issue of considerable value. It is now planned that copies will be placed on sale as souvenirs at Palomar Mountain. As the Observatory buildings were becoming a Southern California attraction even before the mirror was brought down from Tech, we expect the astrophysics issue to have a very large circulation.









UPPER LEFT: Mirror and cell being loaded on the trailer in CalTech's optics laboratory. In the background is the glassed-in observatory gallery.

CENTER LEFT: Preparations for the trip to Palomar Mountain. The mirror and trailer made the right-angle turn out of the optical laboratory at right with three-quarters of an inch to spare. In this picture the eight-wheel dolly between truck and trailer has not yet been attached.

LOWER LEFT: Engineer Bruce Rule taking a vibration meter reading en route.

UPPER RIGHT: Caravan stopped to add two eight-wheel dollies to the trailer. This was done in order to distribute weight more evenly while crossing the Galivan Bridge on Highway 101 above San Juan Capistrano Beach.

CENTER RIGHT: Lowering the mirror into the aluminizing tank at the Palomar Mountain Observatory. The cover to the tank is not shown in this picture.

ENGINEERING AND SCIENCE
Monthly

Vol. XI, No. 1 January 1948

The 200-Inch Mirror is Moved to Palomar Mountain

AT the Institute for 12 years, the Palomar mirror was finally adjudged as near perfect as any mirror could be—within two millionths of an inch of a true parabola—and was transported to Palomar Mountain to be aluminized and mounted in the completed telescope framework.

So much interest had been aroused in the big glass disc that the Public Relations Department at CalTech was hard put to keep information as to when the 200-inch mirror would be moved a secret. The keeping of the secret was made possible by excellent cooperation from newspapers, radio stations and similar agencies. All CalTech knew, however, as preparations commenced a few days before the moving date and a huge semi-trailer was eased into the windowless air-conditioned optical laboratory by sheer manpower.

On Sunday November 16, the mirror, finished since early October, was attached to its 20-ton cell by which it will be mounted in the telescope. Then, slowly, the 35-ton assembly was carried the length of the optical laboratory, suspended by 12 steel cables from 5 overhead tracks.

Swinging like a pendulum bob, but never enough to be dangerous, the huge glass disc was brought down the long 120 feet of the laboratory. After stops for photographs, it was lowered on the semi-trailer adapted for this operation. The mirror was drawn into position by hand onto the trailer bed. Padded side pieces were bolted on, and the lid, a great gray packing box, was moved into a covering position. Only paper and plyboard were actually in contact with the surface of the mirror.

On Monday, the trailer was dragged out of the optics laboratory by winches, and attached to the truck. That afternoon saw the truck and trailer lined up outside the laboratory, with a police officer already controlling traffic. Ropes around the mirror kept the curious at a distance.

At 3:30 a.m. Tuesday, the diesel truck swung into California Street, stopped briefly for more news photographs, and then set off at a speed of five miles per hour, surrounded by a caravan of newsmen and police cars.

Vibration was the chief bugaboo of the astrophysicists, as they shepherded their pride and joy over the 160-mile journey to Palomar Mountain. Crystal pickups installed on the trailer were attached both to a dial in the truck cab and to recorder that produced a permanent trace of the vibrations encountered on the trip. The speed of the truck, governed by the truck cab indicator, varied between 5 and 15 miles per hour.

On schedule, the caravan reached Escondido at 5 p.m. Tuesday after an uneventful trip. Five bridges received aditional shoring to support the 40-ton combined weight of truck, trailer, and its precious load. To cross one coast highway bridge, dollies were placed beneath the trailer, providing a total of 58 wheels to distribute the load more evenly. Recorded deflection of the bridge was three-eighths of an inch.

Twelve hours after the Escondido arrival, the second and last leg of the journey commenced, with the diesel tractor receiving assistance from two pusher units, deemed necessary because of the slippery mountain roads. In spite of poor road conditions and a dense fog which reduced visibility and photographic activity, the mirror reached the Observatory at 11 a.m., seven hours ahead of schedule.

Promptly the mirror was transferred to the aluminizing tank where, in a high vacuum, a layer of aluminum three molecules thick was distributed evenly over its surface.* It is now in the closed tank, awaiting completion of preparations for mounting in the skeletal telescope framework.

The installation, testing, and final adjustments will permit CalTech astronomers to photograph the universe with greater clarity and to greater distances (one billion light years) than ever before. The greater light-gathering power of the 200-inch mirror may answer some of the basic questions of astrophysicists: "Is the universe somehow limited? Is it expanding? Are there galaxies similar to our own at regular intervals throughout space? What is the source of stellar energy? What are the origins of the chemical elements?"

The 200-inch mirror disc was cast in 1935 by the Corning Glass Works and arrived in Pasadena in April 1936. It was unpacked on Easter Sunday of that year and on April 22 it was placed on the grinding and polishing machine. At that time it weighed approximately 20 tons. In grinding and polishing, approximately five and one-quarter tons of glass were removed. To do this required 31 tons of abrasives.

Of the glass removed from the disc, two and one-half tons were ground away in shaping its concave surface. With the disc lying horizontal, its concave face

*Details on the general technique used in aluminizing may be found in ENGINEERING AND SCIENCE for December 1947.

(Continued on page 8)

The *Attitude* Technique in Instrument Flying

By RODERICK K. CLAYTON

BEFORE the outbreak of the recent war, flight by reference solely to aircraft instruments was little understood and was feared by most pilots, who avoided weather which necessitated such flight whenever possible. In military operations, however, frequent instrument flight was required under conditions which hastened the development of new techniques. These conditions are the following:

1. LONGER FLIGHTS: Flights became longer, with the result that a single pilot was often required to fly by instruments without interruption for as much as eight hours
2. ADVERSE WEATHER: It was often necessary to fly under most hazardous weather conditions. As a result pilots frequently encountered icing and turbulence of a degree rarely met in non-military flying
3. EMERGENCIES: The incidence of emergencies in flight was many times greater in war flying than it was in peace-time flying. Instruments and controls were often damaged or destroyed, with the result that difficult problems in instrument flying were created.

NEW INSTRUMENTS AND NEW TECHNIQUES

Prior to the second world war, the development of instrument flying had been guided and limited by the nature and number of flight instruments which existed. These instruments—the turn indicator, the air speed indicator, the altimeter, the climb indicator, and the magnetic compass—are not helpful in giving the pilot a vivid mental picture of the attitude of his aircraft with respect to the ground. Furthermore, prolonged flying under instrument conditions may create sensory illusions which give the pilot an incorrect impression of his aircraft's attitude.

As a result of these factors, instrument flying came to be regarded as a skill entirely distinct from contact flying. The latter was a process in which the aircraft was kept in the desired attitude by coordinated movements of all controls. Instrument flight, on the other hand, was regarded as a strictly mechanical process. Certain readings of the instruments were known to correspond to certain attitudes of flight. The reading of each instrument could be controlled by manipulation of a specific aircraft control.

For example, in a normal climbing turn the desired instrument readings might be as follows: Air speed indicator, 160 mph; climb indicator, 500 fpm ascent; turn indicator, ball centered and needle deflected half its width in the direction of the turn. These conditions could be maintained by controlling the elevators to yield 160 mph air speed, setting the throttles to give a 500 fpm climb, moving the ailerons to deflect the needle half its width, and moving the rudders to keep the ball centered.

The disadvantages of such a technique of flying are obvious. Flying becomes an uncoordinated process characterized by large-scale manipulations of the controls. Such overcontrolling is at best uncomfortable; it may be dangerous when the stalling speed of the aircraft is approached. In any case this mechanical form of flying is fatiguing, and a fatigued pilot is particularly subject to vertigo, inefficiency, and forgetfulness. Fortunately, before the outbreak of the second world war, pilots were seldom required to fly by instruments longer than two hours without relief, and the "needle, ball, air speed" system of instrument flying described above was generally adequate. In the early stages of the war, however, pilots recognized the need for a less tiresome technique of instrument flying to cope with the demands of military operations.

The first step toward the solution of this problem was the perfection and large-scale production of two new flight instruments, the artificial horizon and the directional gyro. The latter, a direction indicator, was designed to replace the magnetic compass except as a primary standard of reference. For reasons to be discussed later, the dial of the magnetic compass is usually oscillating, with the effect that it can be read only with difficulty. This oscillation was a prime source of pilot fatigue before the more stable directional gyro was introduced. A more fundamental contribution to the pilot's instrument panel was the artificial horizon. This instrument, reproducing in miniature the actual attitude of the airplane with respect to the ground, paved the way for the development of a technique of instrument flying identical with the technique used in ordinary contact flying.

As early as 1942, a number of military pilots reasoned that with the aid of the artificial horizon the attitude of the aircraft could be visualized with sufficient clearness to permit the use of the coordinated technique of contact flying. This idea was accepted slowly at first; most experienced pilots, including most flying instructors, were firmly indoctrinated in the mechanical system of instrument flying. By the end of 1943, however, the "attitude" system of instrument flying had gained universal acceptance in the flying schools of the armed forces of the United States.

PHYSICAL TECHNIQUES

The attitude system of instrument flying, as has been indicated, rests upon the formation of a mental image of the attitude of the aircraft. When this image is adequately formed, instrument flying becomes essentially the same as contact flying. Unfortunately, the mental picture does not serve as well as the real visual picture in directing those control movements which seem automatic to the pilot in contact flight.

An illustration of this fact can be found in the simple maneuver of entering a turn from level flight. When an aircraft is banked for a turn, the lift of its wings is no longer directed vertically upward. This partial loss of lift causes the airplane to begin a descent. Under contact flight conditions the experienced pilot compensates for this tendency unconsciously, exerting enough back pressure on the elevator control to avoid a descent as he enters a turn. This action is not, however, completely automatic; it is stimulated by the very slight change in attitude of the airplane as it begins to nose down. One would expect that the artificial horizon would give the pilot such a stimulating indication under instrument conditions; however, this instrument is so small that an appreciable indication does not appear until a significant descent has begun.

It is evident, then, that conscious effort must sometimes be exerted by the pilot to compensate for the imperfect nature of the mental picture formed in in-

strument flight. Some control movements which seem instinctive to the pilot in contact flight are actually stimulated by minute variations of the visual picture of attitude, variations which are imperceptible when transmitted via the instruments.

Control movements which seem instinctive in contact flight but which must be executed deliberately in instrument flight may be listed as follows:

1. When entering a turn, the pilot must apply back pressure on the elevator control to avoid descending
2. When resuming level flight from a turn, he must apply forward pressure on the elevator control to avoid climbing
3. When making a prolonged turn, he must increase power slightly to compensate for loss of lift if he is to maintain altitude and air speed
4. When resuming level flight after a climb or descent, he must anticipate the desired altitude by an amount depending upon the size of the airplane. In heavy aircraft the leveling action must be begun 100 feet before the desired altitude is attained.

SENSORY ILLUSIONS AND PSYCHOLOGICAL EFFECTS

A more serious difficulty met by students of the attitude system of instrument flying is the disturbing influence of sensory illusions and related effects. To fly competently under instrument conditions, the pilot must reject all such illusions and rely solely upon the indications of his instruments. These illusions, which are always present in flight, are contradicted by the pilot's visual or mental picture of the attitude of his airplane. The visual picture which the pilot has in contact flight is so compelling that any sensory illusions are disregarded and usually pass unnoticed. Under instrument conditions this is not the case. The pilot has exerted considerable effort to form a mental picture of his attitude, while a physical illusion may appear spontaneously. Of the two impressions the illusion, being the more natural, is dominant, and the pilot is led to discard the correct mental picture in favor of the illusion.

Thus it is seen that instrument flying is primarily a discipline of the mind over the natural reactions of the nervous system. The pilot must remind himself continuously to act in accordance with a mental impression of attitude formed solely by reference to the flight instruments. All other impressions, however compelling they may be, must be rejected.

A description of the illusions attending flight will clarify the foregoing discussion.

1. When the pilot initiates a climb he is forced downward in his seat; he experiences a sensation of heaviness. Similarly, when he begins a dive he experiences a sensation of lightness. Consequently a feeling of heaviness or lightness, whatever its cause may be, is associated with climbing or diving.
2. If a change in attitude is sufficiently slow it is not noticed by senses other than vision. Consequently a pilot may enter a turn or a bank so slowly that he will think he is still in straight and level flight. If he then returns rapidly to straight and level flight he will experience a sensation of turning or banking in the opposite direction.
3. If a pilot makes a coordinated turn he will experience a force directed straight down into his seat. If he maintains the turn longer than a few seconds he will associate the force with gravity and will receive an illusion of straight flight. As a result, when he recovers from the turn he will experience a sensation of entering a turn in the opposite direction.

If the pilot understands and recognizes these illusions he should not find it difficult to disregard them and to rely solely upon the mental picture imparted by his instruments. He will then find instrument flying to be a safe and relatively simple procedure. If, however, he yields to the illusions, the pilot is likely to encounter serious difficulty.

The serious nature of such difficulty is well illustrated by a description of a maneuver common among student instrument pilots. The pilot is initially in straight and level flight; slowly and imperceptibly he slips into a turn. The loss of lift caused by his banked attitude induces a descent; soon the airplane is descending rapidly in a moderately banked turn. At this point the pilot, still thinking he is in straight and level flight, begins to notice that his air speed is somewhat higher than it should be. Checking his other instruments, he finds to his surprise that they indicate a turn. Obeying the instruments, he recovers from the turn and immediately feels a strong sensation of turning in the opposite direction and of diving suddenly. Disregarding the instruments, which he thinks are out of order, he re-enters his original turn and applies strong back pressure to the elevators. This action serves to increase the degree of bank and rate of turn; the airplane dives more steeply and the air speed increases still more. Alarmed, the pilot increases his back elevator pressure more and more as the air speed increases and the bank becomes steeper; the pilot still thinks that he is trying to recover from a straight dive. The airplane is now virtually out of control.

Unfortunately, this maneuver, popularly known as the "screaming spiral" is not confined to practice flights in which the student is saved by the intervention of his instructor.

The pilot is subject to the following various illusions and mental conditions in addition to those described above:

1. If the clouds surrounding the airplane are lighter in color to the left than to the right, the pilot will associate the left side with "up" and will tend to bank his airplane or lean his body to the left.
2. When flying at night, the pilot will often seek visual reference outside the aircraft instead of relying upon his instruments. He will tend to confuse stars with lights on the ground and vice versa, and will think that lights are moving past him when he is actually turning about the lights
3. The pilot who has flown for more than an hour without rest will become hypnotized very readily by the combination of monotonous engine sound, steady radio signals, and fixed attention.

The pilot can alleviate these three effects by moving about in his seat, shaking his head, and smoking or eating something from time to time.

In summary, the instrument pilot is subject to numerous illusions which obstruct his task of creating a correct mental image of the attitude of his airplane. These illusions can be combatted only by familiarity with them and by unceasing mental discipline against them, aided by as complete a state of physical relaxation as can be attained.

FLIGHT WITH A LIMITED NUMBER OF INSTRUMENTS

The technique of forming a mental picture of attitude during instrument flight was evolved primarily as a result of the development of the artificial horizon. After the technique was established, however, it was found that it could be used advantageously even when the recently developed instruments were absent. The attitude system is now recognized as superior to the old mechanical system of instrument flying under all circumstances, regardless of the number or type of instruments available.

If the pilot must rely solely upon his altimeter and

turn indicator, he will still find it possible to picture the attitude of his aircraft and to fly in a coordinated manner. It is only necessary that he know the characteristics of performance of the type of airplane he is flying. For example, if the altimeter reading is constant, the turn needle and ball are centered, and the power is set for cruising, the pilot can assume that he is in level flight at a certain air speed. If the altitude increases uniformly 500 feet each minute, the turn needle is deflected by its own width, the ball is centered, and the power is set for a normal climb, the pilot can visualize himself as executing a climbing turn at a safe air speed. He also knows that he is turning at a rate of three degrees per second (if the turn needle is so calibrated) so that if his compass is inoperative he can make any desired turn by reference to the time.

In order to fly successfully with a reduced number of instruments, the pilot must learn to extract as much information as he can from the few instruments which are operating. The most important source of "hidden information" lies in the fact that instruments show rates of change as well as actual readings. Much can be learned about the attitude of an airplane from the rate at which air speed is changing; a safe air speed which is decreasing rapidly indicates a more dangerous attitude than does a dangerously low air speed which remains constant.

The possibility of prolonged flight solely by reference to the magnetic compass affords an extreme example of the usefulness of a single instrument. The magnetic compass is subject to two effects which are ordinarily objectionable but which can be used in emergencies to yield information not usually associated with a compass. These effects arise from the fact that whenever the compass is tilted to the eastward or westward it is acted upon by the vertical component of the earth's magnetic force and is caused to turn to a new position of equilibrium. Such a tilting occurs when an aircraft headed north or south begins to turn; this "northerly turning error," the first of the two effects, vanishes when the aircraft is headed east or west. The tilting also arises when an aircraft headed east or west gains or loses speed; the inertia of the freely suspended compass causes it to tilt to the eastward or westward. This second effect, the "acceleration error" vanishes when the aircraft is headed north or south.

If all instruments except the magnetic compass should become inoperative (the magnetic compass is the most rugged of the instruments and the least susceptible to failure), the pilot should first turn to a heading midway between north or south and east or west. At one of these headings both northerly turning error and acceleration error will be appreciable. The pilot is then warned of any tendency to turn by the very sensitive northerly turning error, and he is apprised of any rapid climbs or dives by the less sensitive but adequate acceleration error. He can detect a gradual gain or loss of speed by increasing or decreasing responsiveness of the airplane to pressures upon the controls. Thus the pilot can maintain controlled flight until he has flown clear of the instrument weather area.

THE IMPORTANCE OF SELF-CONFIDENCE

The greatest asset to competent instrument flying is self-confidence, gained through constant practice in flying by means of a limited number of instruments and under actual instrument weather conditions. The self-confident pilot is able to think clearly and constructively; his thoughts are not diverted by fear and doubt.

Practice under an instrument flying hood is a prerequisite to flying in actual instrument weather, but it is not a perfect substitute. Every pilot is tense and apprehensive when he first finds himself "in the soup," and it is not until he has flown many times under actual instrument conditions that he acquires the full assurance which enables him to fly well by instruments and to deal efficiently with emergencies.

CONCLUSIONS

In summary the following conclusions may be drawn:

1. When flying by instruments the pilot must form a mental picture of the attitude of his aircraft from the indications of his instruments
2. In instrument flight, the pilot must make deliberately some control movements which seem instinctive in contact flight. These movements are stimulated by small changes in attitude under contact conditions; the instruments are too insensitive to produce these stimuli
3. The pilot must disregard all sensory illusions in flight and must determine his attitude solely from the indications of his instruments
4. The pilot must be physically relaxed to fly well and to avoid hypnosis and illusions of leaning
5. When some instruments are inoperative, the pilot can usually derive enough information from the remaining instruments to continue normal flight under instrument conditions
6. The pilot must have complete confidence in himself, gained only through frequent practice in actual instrument weather, if he is to fly efficiently by instruments and avoid accidents in emergencies.

The 200-Inch Mirror is Moved to Palomar Mountain

(Continued from page 5)

would provide a basin large enough to hold approximately 256 gallons of water. Approximately 24 inches thick at the edges and 20¼ inches at the center, the mirror has a solid face approximately four inches thick. Ribbing on the back accounts for the much greater actual dimension. In its center is a hole 40 inches in diameter, which incidentally is exactly the same diameter as the largest refracting telescope lens at Yerkes Observatory. During grinding and polishing this hole was plugged. Installing the big glass plug, a much greater engineering problem than its removal, was accomplished by the simple method of placing the plug on a cake of ice which protruded above the surface the disc. As the ice melted, the plug sank slowly into position.

Although work on the mirror started 11 years ago, World War II brought a halt for four years. Those working on the mirror turned to war projects, and in the same room where the mirror awaited the end of hostilities, critically needed optical work was done. A number of mirrors, some of them 36 inches in diameter, were ground and polished for the armed forces and sent to such places as the Aberdeen Proving Ground, Wright Field and Langley Field. Approximately 1100 right-angle prisms were made for the armed forces in adition to other optical work.

Work was resumed on the 200-inch mirror on December 17, 1945 and continued until October 3, 1947. Approximately 180,000 man-hours were required to grind and polish it.

C. I. T. NEWS

Y.M.C.A. SPONSORS "FIRESIDE" SERIES

TO give students the opportunity of meeting faculty members and prominent Pasadenans informally, the CalTech Y.M.C.A., under the leadership of Secretary Wesley Hershey, inaugurated a Sunday Evening Fireside Series at the beginning of the fall term.

On a sign-up basis, students accepted invitations from faculty members on successive Sunday evenings. With the exception of the Linus Paulings, who specified freshmen only for three successive Sundays, and then invited upperclassmen and graduates as well for a fourth, two to four faculty hosts extended an invitation to all four classes and graduate students each week.

Two hours of discussion—usually of everything but the host's professional subject—and light refreshments molded opinion unanimously in favor of Fireside continuation, and lists were filled before finals for the first hosts of the winter term, Drs. Lee A. DuBridge and Robert A. Millikan.

PAULING RECIPIENT OF ROYAL SOCIETY MEDAL

THAT Dr. Linus Pauling, head of the Division of Chemistry at the Institute had been awarded the "Davy Medal" by the Royal Society, London, was announced late in November. Dr. Pauling became the second CalTech professor to receive this honor, the first being the late Dr. A. A. Noyes, first chairman of the Chemistry Division, under whom Pauling studied.

Dr. Pauling's contributions to understanding of the nature of chemical bonds—the means by which atoms are bound together to form molecules; his work in the fields of immuno-chemistry and the chemical structure of proteins and other chemical compounds in relation to the biological fields has been outstanding, and it is for such work that this award was made. The award citation reads "for his distinguished contributions to the theory of valency and their application to systems of biological importance."

Although he was unable to be present at the Anniversary Meeting of the Royal Society, December 1, to receive the medal in person, Dr. Pauling will leave immediately after Christmas for England where he is to be Eastman Professor at Oxford for the second and third terms.

LINDVALL TELLS ENGINEERING'S PLANS,

CALTECH'S current aims in the engineering curricula were expressed clearly at the December meeting of the Alumni Association by Division Chairman Frederick Lindvall. Less and less specialization is the trend today, in line with the assumption of responsibility by industry for finishing the training of young engineers. Instruction in attractive new fields of specialization such as radar is being kept to a minimum at the Institute. The basic plan of the Institute to do a few things well guides the engineering development.

Identical courses through the junior year for ME and EE undergraduates, with the requirement of a junior course in advanced mathematics, is indicative of the new training. That comparatively large numbers of men are affected by these trends is shown by the fact that 65 per cent of undergraduates and 60 per cent of graduate students, excluding chemical engineers, have chosen the engineering option.

The teaching load is heavy and current research interests, covering aerodynamic structures, hydrodynamics and vibration problems, rapid loading of materials, and axial flow compressor design, are placing a burden on CalTech's small engineering faculty. Additions both of facilities and faculty are necessary to reduce the teaching loads now carried by members of the Division and bring about a better balance between teaching and research.

TECH ATHLETICS NOW BETWEEN SEASONS

END of the football season saw Tech at the bottom of Southern California Conference standings with three losses and one tie—with Whittier. This was a year of close ones; the Beavers' first string was as good as any in the Conference, but lack of reserve strength comparable to the other schools encountered told on the CalTech team in every case. In both the Pomona and Redlands games, Tech held a lead, but was unable to maintain strength necessary to protect the score.

Outstanding in the fall sports field was the cross-country team. With Conference victories over Pomona and Occidental, plus a non-league win against Santa Barbara, Beaver Harriers suffered only one loss—to Redlands, at the Conference Meet, held Tuesday, December 9, at Tournament Park.

Tech basketball, coached by Carl Shy, is still an unknown quantity. The only two encounters at press time were with Muir J.C., won 42-35 by the Beavers, and a 49-37 loss to the Pasadena Nazarenes, formerly Pasadena College, at the Redlands Invitational Tournament. The Dark-horse Nazarenes took a win from host Redlands in the first round, vanquished Tech and then beat Loyola, seeded second for the tournament. Whittier finally broke the Nazarene's string of victories in the final round to take the Tournament.

As Tech had a bye in the opening Tournament round, the Beavers were not eligible for the consolation round, which was won by Pomona.

1948 BASKETBALL SCHEDULE

*Friday	January 9	CalTech at	Occidental
Saturday	January 10	CalTech at	Pepperdine
*Friday	January 16	Redlands at	CalTech
Saturday	January 24	Chapman at	CalTech
*Friday	January 30	Occidental at	CalTech
Saturday	January 31	CalTech at	Loyola
*Friday	February 6	CalTech at	Redlands
*Tuesday	February 10	Whittier at	CalTech
*Friday	February 13	CalTech at	Pomona
*Friday	February 20	CalTech at	Whittier
*Friday	February 27	Pomona at	CalTech
Saturday	February428	Loyola at	CalTech

*Conference games

All home games will be played at the National Guard Armory at 146 North Raymond, Pasadena. Varsity games will start at 8:15 p.m. There will be a freshman preliminary at all games, starting at 6:45 p.m.

INSTITUTE RECEIVES NAVY COMMENDATION

A commendation award for effective cooperation in training naval personnel during World War II was presented to the Institute Friday, December 5, at the 11 a.m. assembly in Culbertson Hall by Rear Admiral Oscar C. Badger, USN, Commandant of the 11th Naval District.

The presentation on the campus of this award which was made to C.I.T. during Navy Week, was arranged for members of the student body, faculty, and others, and was made to Dr. L. A. DuBridge. Also on the program was Dr. R. A. Millikan, head of the Institute during the war years. Registrar L .Winchester Jones spoke on the Navy training program as it was conducted at CalTech.

ALUMNI NEWS

ALUMNI ASSOCIATION OFFICERS

PRESIDENT
W. M. Jacobs '28

SECRETARY
D. S. Clark '29

VICE-PRESIDENT
H. B. Lewis '23

TREASURER
H. R. Freeman '25

BOARD OF DIRECTORS

J. R. Bradburn '32
E. R. Hoge '18
A. L. Laws '26
J. W. Lewis '41
W. B. Miller '37
F. T. Schell '27
W. D. Sellers '25

ALUMNI CHAPTER OFFICERS

New York Chapter:

PRESIDENT — H. E. Mendenhall '23
Bell Telephone Labs., Murray Hill, N. J. — Summit 6-6000
VICE-PRESIDENT — Clifford C. Burton '40
The Texas Co., 205 E. 42nd St., New York 17, N. Y., MU 9-7700
SECRETARY-TREASURER — Richard T. Brice '37
Otis Elevator Co., 260 Eleventh Ave., New York 1, N. Y., CH 4-8000

San Francisco Chapter:

PRESIDENT — Ted Vermeulen '36
2226 McGee Avenue, Berkeley 3, California — THornwall 3475
University of California Chemistry Department — AShberry 6000 E
VICE-PRESIDENT — Robert P. Jones '35
1431 Park Blvd., San Mateo, California, Tel. San Mateo 3-7634
Standard of California — Tel. SUtter 7700
SECRETARY-TREASURER — John C. Harper '40
5800 Buena Vista Ave., Oakland 11, California, PIedmont 8672-M
Standard Oil Refinery, Richmond, California, Tel. RIchmond 7800

The San Francisco Chapter meets weekly for lunch at the Fraternity Club, 345 Bush Street, on Thursdays.

RAYMOND O. CATLAND

RAYMOND O. Catland '15 died in Boston in November. Prior to his death, Catland was an engineer with the Union Twist Drill Co., Athol, Massachusetts, working on the development of new carbide tools. He also served the Company on several special engineering assignments.

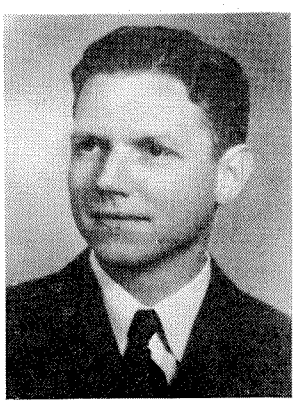
From January 1944 to December 1946, Catland was in charge of the W.P.B. project for the study of carbide milling at M.I.T. Approximately $350,000 was spent by the project to determine the fundamental factors involved in milling steel and dural with carbide tipped tools. Previous to this work, he was with the Engineering Department of Lockheed and Vega Aircraft Companies, where he was responsible for much of the early development of carbide milling.

CHEMISTRY GRADS LISTED IN A.C.S. SECTION POLL

"CHEMICAL Bulletin," of the Chicago Section, American Chemical Society, listed in its November issue six C.I.T. men among the "ten ablest chemists and chemical engineers" now working in the United States in each of 20 specialized fields. Don M. Yost '26, professor of inorganic chemistry at the Institute, was listed in the Inorganic Chemistry classification; Charles D. Coryell '32, Ph.D. '35, professor of chemistry at M.I.T. was named to the Nucleonic Group; Linus Pauling '25, chairman of the Institute Chemistry Division, and K. S. Pitzer '35 of the University of California, were ranked as top-flight physical chemists; A. R. Kemp '17 of Bell Telephone Laboratories, Rubber Chemistry; and R. E. Rundle '41 of Iowa State College, was included in the Starch Chemistry classification.

Those honored were selected as the result of a reader poll, with each reader voting in his own field of chemical activity. In an editorial, the "Bulletin" stated that: "So far as we know, this is the first time chemists and chemical engineers have reecived public recognition based entirely on fellow-specialists' appraisal of their scientific work."

JAMES H. JENNISON '35 WINS WELDING AWARD



JAMES H. JENNISON '35 was announced winner of a $2000 second place award in the Design-For-Progress Award Program sponsored by the James F. Lincoln Arc Welding Foundation, the first of November. Jennison, the head of the Development Engineering Section of the U. S. Naval Ordnance Test Station in Pasadena, described the design and construction of a movable bridge of 300 ft. span for Naval Ordnance testing facility. The bridge is supported on a float at one end and on a carriage travelling on a 45° slope at the other end. In a comparison of welded and riveted designs, a saving of $90,000 was indicated by welding.

Jennison received his B.S. degree in 1935 and the M.S. in 1936, both in civil engineering. For seven years he was a civil engineer in the Bridge Department of the California Division of Highways. As head of the Developmental Engineering Section, he supervises the designing and development of ordnance devices and testing facities in the field of underwater ordnance.

PRECEDENT SET AS ALUMNI MEETING SPEECH BROADCAST

HIGHLIGHTED by the speech of California's Lieutenant Governor, the December 4 meeting of the Alumni Association also inaugurated short talks by faculty members on current Institute activities. Another feature of note was the transcription and subsequent broadcast of Lieut. Gov. Goodwin J. Knight's speech, "American Comes of Age."

Biology Professor George Beadle was introduced to the alumni by President Mort Jacobs. Dr. Beadle, chairman of the Division of Biology since July 1946, is considered one of America's best biochemists.

A short talk on "Current Engineering Interests at the Institute" by Professor Frederick Lindvall '28, chairman of the Division of Civil and Mechanical Engineering and Aeronautics, was a feature of the meeting which, it is anticipated, will be repeated in the future. Dr. Lindvall's discussion is reported in some detail in the **C.I.T. News** section on page 9.

President Jacobs introduced George Whitworth '20,

who arranged this meeting. Mr. Whitworth presented Lieut. Gov. Knight.

Knight reviewed the growth and character of early political leadership in America and contrasted it with that new leadership which has arisen in our country within the last few decades.

Before 1900 it was the lawyer, he pointed out, who, by reason of his training, knew the "rules" of politics and was the dominant figure in public life. Beginning in the 1890's, however, the growing necessity for specialization on the part of lawyers required that they devote more time than before to their field and less to politics.

A simultaneous renewal of interest by the general public in civic and governmental affairs brought about a new leadership in which all classes, professions, trades, and businesses took a strong and active part.

This alertness of the general population to every new law and decision, to every new political and social movement, has erected one of the greatest bulwarks against the growth of Communism, Fascism, Naziism, or any other totalitarian and anti-American philosophy in our country.

Lieut. Gov. Knight's talk was transcribed and broadcast the next day, Friday, December 5 by Pasadena station KWKW.

FRED PETERSON '27 DISCUSSES JOB HUNTING

ARRANGED by the Alumni Placement Service, H. F. Peterson '27 discussed placement opportunities and the technique of applying for a job at an evening meeting December 10. Peterson, manager of the Surveying and Drafting Departments of the Shell Oil Co.'s Los Angeles Office, has had a great deal of experience in hiring engineers.

DONALD R. THOMPSON '27 GETS CITRUS EXCHANGE PROMOTION

DONALD R. Thompson '27 has recently been appointed assistant manager of the California Fruit Growers Exchange Products Department. Thompson joined the Exchange's Research Department immediately after his graduation in chemical engineering. In 1929 he transferred to the Sales Division of the Products Department and since that time has held the positions of assistant to the manager and Western Division manager in charge of all citrus product sales in the 11 western states.

Thompson is very well known for his valuable contributions to the food processing industry, and holds many patents in the food technology field.

CALTECH-OXY ALUMNI LUNCHEON A SUCCESS

TWO days before the Tech-Oxy football classic on October 24, about 80 sideline quarterbacks representing the two schools met for luncheon at the Pasadena Athletic Club and threw both orchids and bricks at each other. Dr. Lee A. DuBridge of CalTech and Dr. R. E. Fitch, faculty dean of Occidental standing in for President Coons, served as moderators while Coaches Roy Denis of Oxy and Mason Anderson of Tech convinced all present that their respective teams didn't stand a chance. A color picture of last year's U.C.L.A.-Illinois Rose Bowl game brought an end to the verbal gridiron antics.

With the Board

HOWARD Lewis '23 and Joe Lewis '41 are making considerable progress in organizing the Alumni Fund Campaign. Although active work on solicitation of contributions has not begun, the publicity so far given the plans has resulted in several contributions. But Howard and Joe are doing a lot of organizing, lining up men from all classes to help in seeing all alumni. Many men remember vividly the persistent plea for a gymnasium when they were undergraduates and are glad to become a part of an organization to provide that long-standing need. If you are asked to help solicit or to contribute, pitch in generously and repay part of your debt to Tech by aiding those now there.

* * * * *

A couple of months ago it was reported in this column that Earl Burt '15 was completing the Manual of Operations. We regret to report now that Earl has had to give this up for reasons of health. We are glad, however, to announce that another hard worker and dependable alumnus, Carl Friend '38, has taken over and again predist the job will be done soon.

* * * * *

Doug Sellers '25, director in charge of membership, announced at a recent meeting of the Board that membership in the Association is now greater than at the same time last year. It appears that some of the recent growth is attributable to the most recent reminder which was sent in October with a copy of the November issue of **Engineering & Science** to non-member alumni. He believes, however, that many potential members are just waiting for a personal reminder from a member and he hopes that you will suggest to your eligible friends that they too sign up.

* * * * *

Jim Bradburn '32 told the Board at the November meeting that the Directory would probably be ready for distribution by early spring. In order to reduce expenses it is planned to have only an alphabetical listing. Experience has shown that this is by far the most used listing and it is felt that little will be sacrificed by omitting the geographical and class year listings. Be sure you and your friends have sent in their questionnaires properly filled in. If you've lost the questionnaire, just write your name, class, addresses, occupation, and employer's name on a penny postcard and send it to the Alumni Office marked "For the Directory."

H. K. F.

ALUMNI FUND PROGRAM DISCUSSED BY CLASS REPRESENTATIVES

IN line with the articles by Howard Lewis '23 in the June and November issues of **Engineering & Science** about the Alumni Fund Program, a meeting of class representatives was held at the Athenaeum on November 10. The purpose of this meeting was to familiarize class representatives with the general fund plans. In addition to the class representatives, President Lee A. DuBridge, James R. Page, president of the Board of Trustees, a few members of the faculty, and members of the Board of Directors and Officers of the Alumni Association attended the meeting. Allan Laws '26, past president, outlined the activities of the Alumni Association and discussed the methods of operation.

Joe Lewis '41, a member of the Alumni Fund Study Committee under the chairmanship of Howard Lewis, reviewed the development of the Alumni Fund program. At a meeting of the Board in April 1946, the President of the Association was requested to appoint a Fund Study Committee. A committee, consisting of Howard Lewis '23, chairman, Harold M. Huston '29, J. R. Joujon-Roche '28, J. W. Lewis '41, Earl Mendenhall '18, H. B. Holt '15 met several times and made extensive studies of Alumni Fund programs. This committee recommended to the Board of Directors that the Association establish a program for the purpose of raising funds for the benefit of the Institute. Joe outlined a program of organization, which included the establishment of a directing committee consisting of one man from each of a group of classes to coordinate the activities of the class representatives. The program calls for the organization of class committees.

Herbert Holt '15 spoke briefly on the obligation of the Alumni to the Institute in view of the cost of education in relation to tuition paid. He referred to the work of the Institute Associates in contributing to the financial support of the Institute and expressed the belief that more alumni should contribute.

Harold Musselman commented briefly on the increasing need and urgency for gymnasium facilities. He pointed out that it is now practically impossible to secure a place for basketball. Professor R. W. Sorensen amplified Hal Musselman's comments on the needs of the Institute, and offered his full support.

President DuBridge expressed the great pleasure of the Institute in the program of the Alumni and particularly in the spontaneity of the Alumni in developing this program and offering it to the Institute rather than the Institute asking the Alumni to help. He stated that he had high hopes for a profitable cooperation between the Institute and the Alumni.

James R. Page spoke on the importance of assistance by the Alumni and firmly recommended that a definite goal be established and the program be set in motion without delay.

The classes were represented by the following men:

R. D. Andrews	1896-1915	R. C. Armstrong	1928	H. M. Worcester Jr.	1940
B. E. Chamberlain	1916	P. Cravitz	1929	S. E. Sohler	1941
J. P. Youtz	1917	C. E. Giebler	1930	R. M. Head	1942
E. R. Hoge	1918-1919	E. F. Green	1931	E. J. McCartney	1943
R. E. Woodbury	1920	H. W. Finney	1932	J. R. Borden	June 1944
R. J. Hare	1921	J. E. Meskell	1933	R. F. Mettler	October 1944
G. A. Alles	1922	L. F. Etter	1934	D. C. Tillman	1945
L. E. Blakeley	1923	A. A. Ray	1935	H. M. Comlossy Jr.	Feb. 1946
E. H. Gandy	1924	H. B. Dickinson	1936	H. R. Woods	June 1946
W. Hertenstein	1925	P. C. Schaffner	1937	M. Eimer	1947
J. E. Kinsey	1926	C. W. Clarke	1938	L. Mittenthal	1948
K. A. Belknap	1927	W. G. Lawson	1939		

The class representatives elected the following men to serve as a directing committee:

J. W. Lewis '41	Chairman	A. A. Ray '35	Classes of 1933 - 1940 Inclusive
G. A. Alles '22	Classes of 1896 - 1923 Inclusive	S. E. Sohler '41	Classes of 1941 - 1948 Inclusive
J. E. Kinsey '26	Classes of 1924 - 1932 Inclusive		

PERSONALS

1918

NOEL A. PIKE is now with the Arizona Electric Coordinating Committee in Phoenix.

1922

KENNETH A. LEARNED, effective December 1, 1947, became the exchange outside plant engineer for the Southern California Area of the Pacific Telephone and Telegraph Company. For the past three years, Ken has been district engineer for the Alhambra Engineering District, which includes the Pasadena, Alhambra, Arcadia and El Monte Telephone Exchanges.

1925

THOMAS P. SIMPSON was among more than 40 members of the staff of the Research and Development Department of the Socony-Vacuum Oil Company, Inc., at Paulsboro, N. J., who participated November 17 in installation of a new Socony-Vacuum unit of the Society of Sigma Xi, national organization for the encouragement of scientific research.

1927

THEODORE C. COMBS has been transferred to serve as resident manager for Timber Structures, Inc., in charge of the company's activities in the Southwest and Mexico. His office will be in San Francisco. Combs was formerly in the firm's home office in Portland, Oregon.

1931

AUBREY HORN has recently moved from South Pasadena to the vicinity of Cottage Grove, Oregon where Aubrey is chief engineer for the construction of the Dorena Dam.

1932

PATRICK B. LYONS, New Jersey, is now with Western Electric Co., Inc. as assistant superintendent in charge of sales, Hearing Aid Dept.

1933

ALBERT A. KOCH, engineering consultant, is a faculty member at the New Mexico School of Mines.

1933

WILLIAM W. MOORE, president of Structural Engineers Association of Northern California, presided at the meeting of the annual convention of the Structural Engineers Association of California, which was held at Yosemite National Park in October.

1935

GALE M. SMITH, employee of American Telephone & Telegraph Co., New York assisted in a recent project of considerable interest which involved furnishing telephone service to passengers on the "Congressional Limited" and other crack trains of the Pennsylvania Railroad, and to passengers on the B & O Railroad's "Royal Blue". Speeding between New York and Washington at 90 miles per hour, passengers can place calls to any telephone in this country or abroad.

HARRY WILSON is with the A. C. Nielsen Co., which for the past 15 years

has specialized in marketing research, with branch offices in England and Canada.

1936

CHARLES W. BEST announces that his wife presented him with a baby girl, Margaret Ann, late in October. Best is employed by the J. H. Baxter Company of Long Beach, Calif.

R. TYLER THOMPSON writes that he spent six years in Singapore, including 42 months in a Japanese internment camp.

1937

WENDELL B. MILLER recently became area engineer in charge of outside plant engineering for the Arcadia and El Monte Telephone Exchanges. (This does not mean, Wendell advises, that he will be able to get you a telephone in these areas.) Wendell, with a boy and two girls now in his family, has been forced to proceed with additions to his present house, and construction of "Miller Park" is well under way. He extends a cordial invitation to his friends to drop in any time.

DEAN NICHOLS has completed his Fellowship in the Mayo Foundation and is now practicing medicine, specializing in Dermatology and Syphilology in Helena, Montana.

1938

HENRY K. EVANS is located in San Mateo with the DeLeuw, Cather & Co., Consulting Engineers, as traffic and transportation engineer, and is resident engineer in San Francisco on the traffic and transportation planning survey now in progress. This survey involves plans for improving trucking and street transportation facilities in the city.

1939

WALTER A. DIEHM is now employed as an industrial engineer at the West Linn, Oregon Division of Crown Zellerbach Corp. Diehm recently received the M.B.A. degree from the Stanford Graduate School of Business Administration.

1941

JOHN G. PARTLOW was married in August, 1946, to Miss Imogene Burgess of New Martinsville, West Virginia. They have bought a house in Edgewood, a suburb of Pittsburgh, Pa., and find the job of remodeling it very enjoyable. John is an electrical design engineer for A - C turbo generators at the East Pittsburgh plant of the Westinghouse Electric Corp.

1942

WM. J. KENNEDY, after five years in the Research Dept. of United Aircraft Corp. in Conn., has been sent on leave of absence for a year at the NEPA Division of Fairchild Engine & Airplane Corp. in Oak Ridge, Tennessee. Kennedy, who married Miss June Olcott Roberts of Wethersfield, Connecticut, in 1943, now has two sons.

1943

DAVID R. ARNOLD received his M.B.A. degree from Stanford in December and will enter the public accounting field in Los Angeles after the first of the year.

AMASA STONE BISHOP married Miss Barbara Merrill of Wollaston, Mass. on December 20, in Berkeley. Miss Merrill was graduated from Vassar College in 1942, and received her Ph.D. in psychology in 1946 from the University of Iowa.

Bishop was a staff member of the Radiation Laboratories at M.I.T. for three years, and now is working toward a Ph.D. at the University of Calif.

JESSE B. GRANER is taking graduate work in Petroleum Engineering at U. S. C.

DEANE N. MORRIS is proud to announce that in October his wife, Clariata, presented him with a son, Ronald James. This is the Morris' first child. Morris is at present employed at Bell Aircraft Corp. as an aerodynamicist, working mainly on supersonic aerodynamics.

1944

WILLIAM H. BOND is proud to announce that he is the father of a son born November 9. Bond is with Consolidated Vultee Aircraft Corp. in San Diego, as a thermodynamicist.

DONALD A. KEATING recently married Miss Viola Lucile Neubert at Kansas City, Missouri. Keating is technical service director for the Mid-Western Division of Turco Products, Inc.

FRED W. MORRIS is now teaching with the new Head of Electrical Engineering at USC, DR. GEORGE HARNESS '33.

EUGENE W. PETERSON has married the former Miss Lorna C. Thomas of Pasadena, Calif.

1945

MARK M. MACOMBER is back in the Navy and is engineering officer aboard the LST 854. The ship is now operating out of Tsingtao, China, hauling cargo along the China Coast.

RICHARD F. NEERKEN with Worthington Pump & Machinery Corporation has recently been transferred to the Phoenix area and will move there permanently after the first of the new year.

1946

WILLIAM E. KINNEY lt. col. in the Air Corps, was killed in an airplane crash at Wright Field, Dayton, Ohio on May 22, 1947.

ELLIOTT O. STEPHENSON has been appointed chief assistant to the superintendent of the City of Pasadena Building Department.

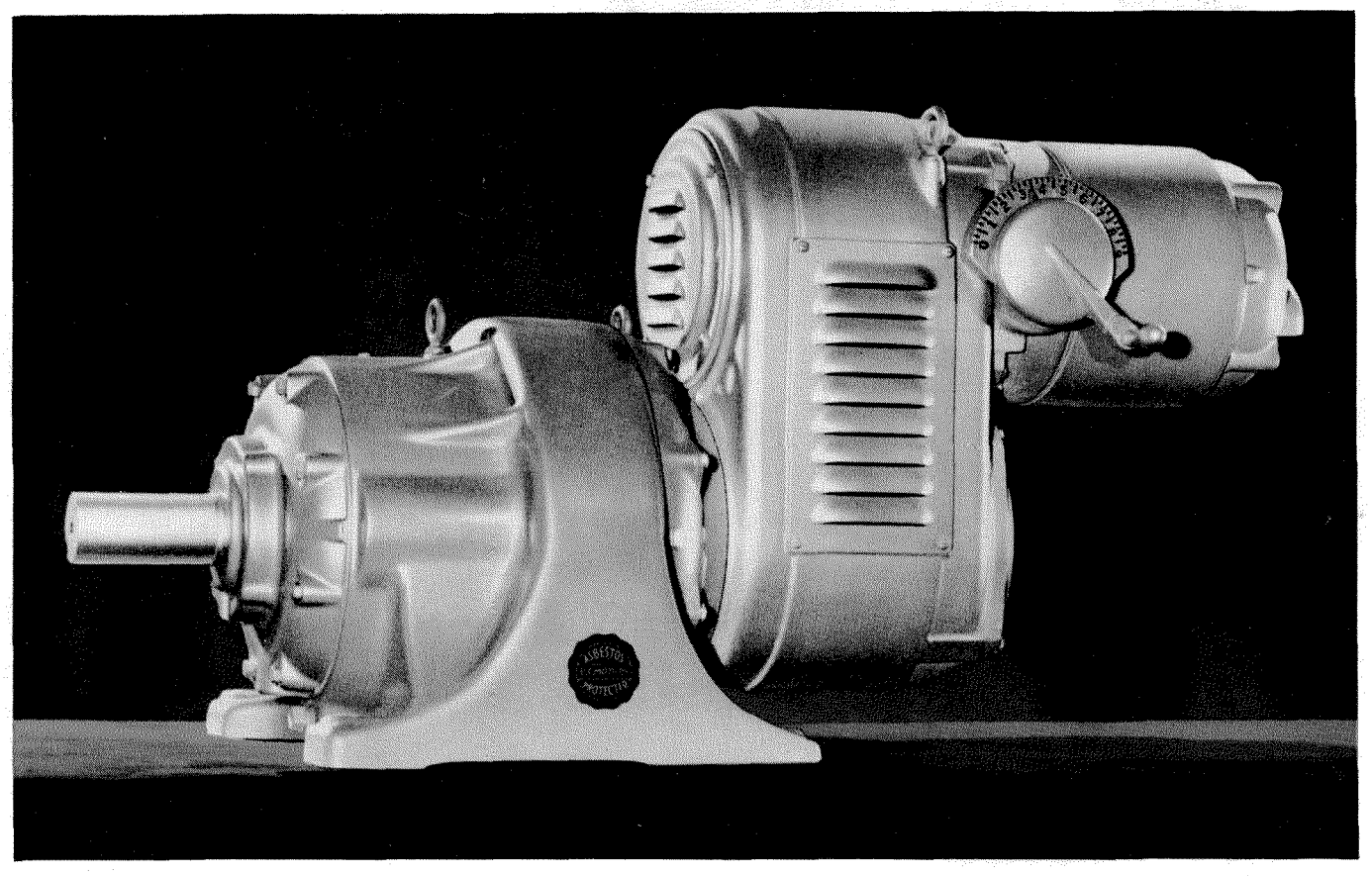
During the war Stephenson served as an Army captain, spending a year and a half in the South Pacific.

1947

DAVID P. SHOEMAKER is attending the University of Copenhagen in Denmark.

BOB UTSCHIG now with the San Diego Division of Consolidated Vultee Aircraft Corp., tells us the following '47 graduates are there also: FRANK DORE, HAROLD HIPSH, RICHARD SMITH, AND ERNEST WADE.

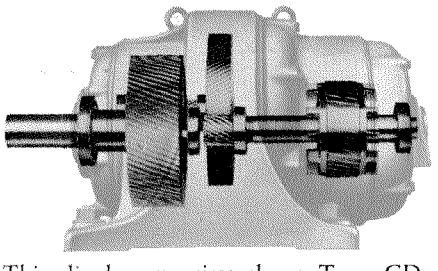
JERARD B. WERNER is now employed by North American Aviation, Inc., at the Los Angeles Municipal Airport.



Type VEV-GD—Double Reduction Combination Varidrive-Syncrogear

THE GEARED MOTOR WITH PYRAMIDAL STABILITY

Structural rigidity is of primary importance in a geared electric motor. *The U. S. Syncrogear* motor consists of a heavy, one-piece pyramidal base casing, within which is mounted the gear trains. Model VEV-GD, illustrated above, shows the Syncrogear in combination with a U. S. Varidrive motor, to obtain very low but *variable* speeds. You can also obtain the Syncrogear with constant speed motors. In the Syncrogear, electrical design is coordinated to give optimum overall performance. The unit is most compact, occupying little more space than an ordinary motor. It incorporates the basic U. S. Motor features including asbestos protection, normalized castings, solid cast aluminum rotor and Lubriflush lubrication. For ever-dependable geared power, install the *U. S. Syncrogear.*



This diaphanous view shows Type GD Double Reduction U. S. Syncrogear. Note its compactness. Various types of Syncrogears are available, to meet any requirement for geared electric power.

U. S. SYNCROGEAR MOTOR

offers these desirable features

1. *Rugged pyramidal base.*
2. *Gears hardened to 45/50 Rockwell C.*
3. *Quiet, long-life operation.*
4. *Precision-finished helical gear train.*
5. *Gears held in permanent alignment.*
6. *Fully-enclosed, easily cleanable.*
7. *Anti-friction, high efficiency bearings.*
8. *No rubbing seals to cause leakage.*
9. *Solid integral shank pinion.*
10. *Effective gear-dip lubrication.*

Double, single and triple reductions are available, in sizes of ¼ to 30 h.p. and standard AGMA speeds of 10 rpm. to 10,000 rpm.

New illustrated engineering Bulletin upon request

U.S. ELECTRICAL MOTORS Inc.

Atlantic Plant: Milford, Connecticut

Pacific Plant: Los Angeles 54, California

District Offices: Boston 16—New York City 6—Philadelphia 2—Pittsburgh 22—Chicago 8—San Francisco 7—Seattle 4

Sales and Service offices in all principal cities