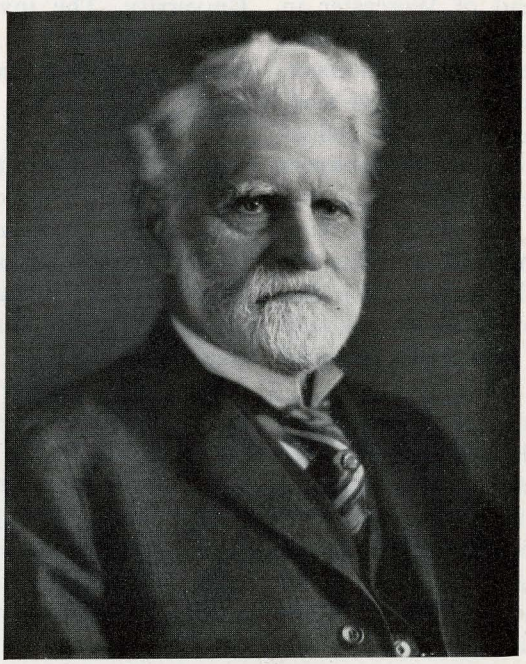
Ambrose Swasey
Builder of Machines, Telescopes and Men

By J. J. NASSAU

"You know, it wasn't so long ago since Galileo was put into prison for saying that the world was round and that the sun was the center of the Universe," once said Ambrose Swasey. "That was not so very much before my time, only one hundred and twenty-five years before the birth of my grandfather whom I remember well. People now do not know much more than they did then." And yet people do know more on account of Ambrose Swasey for he built giant telescopes that pierced the depths of space and devoted his talents to science and engineering, leaving a lasting influence upon his age. On June 15, 1937, he died, a great task completed, four score and ten years of noble living.

Childhood

THE Swasey family have been residents of New England since 1686. They immigrated to this country from England. Ambrose was born on December 19, 1846, the son of Nathaniel and Abagail Peavey Swasey and was the ninth of ten children. Nathaniel Swasey, a progressive farmer of Exeter, New Hampshire, was sufficiently skilled in the mechanical arts to make his own tools and wagons, and young Ambrose must have learned to do things with his hands on the farm. The study of ancient history and astronomy occupied the intelligent interest of this New England farmer. From his father Ambrose doubtless got his trait of intellectual curiosity. From his mother he inherited his cheerful disposition and his vein of quiet humor with which for years he delighted his associates.



There were no mechanical toys when Ambrose was very young but he soon learned to make his own. Mother's old spinning wheel and his jackknife helped in making a flax wheel. The old attic was his workshop and there he set up an improvised lathe. Then he made a working model of a mowing machine which is still in existence. Boys on old New England farms all had duties and Ambrose was in charge of the sheep and lambs which he loved and gently cared for. When Eben, his next older brother and close companion, was in college, young Ambrose took him to school every Monday morning and called for him on Friday afternoon, often driving through heavy snow drifts.

The brothers got into their share of difficulties. When Abraham Lincoln went to Exeter to visit his son Robert who was attending the Academy, Eben and Ambrose thought it fitting to celebrate this unusual event by building a bonfire. This they did on a hill back of their house and nearly succeeded in burning the old homestead.

Apprentice—Meeting W. R. Warner

"Although all my brothers and sisters went to academies or colleges, my only schooling came from the little country grammar school and lasted only two or three months," said Swasey. But he received half a dozen degrees from leading Universities, helped to shape higher education in America and led in the development of scientific and engineering research.

He made his final decision upon a career in 1865 when he told his father he would like to learn the machinist's trade. Up to that time the hope of the family was that he would follow his brothers and sisters to some institution of higher learning. But he went to a newly established machine shop in Exeter. A year later, another young man of the same age and as eager to learn as Ambrose came from Boston and started to work in the same shop. This young man was Worcester R. Warner. The two enthusiasts soon became warm friends.

As Ambrose started ahead of Worcester in the apprentice work, he finished first, and then to widen his experience he went to Paterson, N. J., to enter the employ of a locomotive firm. He soon found the work unsuited to his inclinations and perhaps, too, a bit of homesickness hastened his return to Exeter. Once again the two young friends spent the winter working together in the shop, living and studying together, and planning for the future. This was the development period of two astonishingly parallel characters, not in any sense identical but rather, complementary.

It may be said that the spring of 1869 marked the beginning of their life long partnership, for at that time they wrote letters to four companies seeking positions as machinists. The result was four offers. As was to be expected they made the same choice. After their first day's work at the Pratt and Whitney shops in Hartford, Connecticut, Warner remarked to Swasey, "Well, Ambrose, we have a very difficult job. There are three hundred young men ahead of us." But soon they attracted attention by their special abilities in solving mechanical problems, and the number ahead of them diminished, for both were given important positions which they held until they left the employ of the company eleven years later to start out independently to establish a business of their own.

Cornell Offer

The training he received on his father's farm, the experience he gained in the Exeter machine shop where men found joy in good workmanship, the long hours spent in his room at night studying books on machines, all showed their first fruits soon after Ambrose Swasey joined Pratt and Whitney. At thirty-two, he was made superintendent of the gear cutting department. A year later, through study and development at his home nights, he produced a beautiful piece of mechanism, the epicycloidal gear engine. It was constructed in the shop under his direct supervision and proved to be a success. His inventive ability, his breadth of knowledge both theoretical and practical must have been recognized beyond the limits of this New England shop, for in 1879 he was invited to succeed John E. Sweet, professor of Practical Mechanics at Cornell University. The invitation surprised him. He underestimated his ability, self-training, and experience and he declined the offer.

First Patent

Being in charge of the gear making department was not sufficient occupation for the energetic mind of the young machinist. He found time to invent and obtain a patent for an improved protractor, an instrument for laying and measuring angles with great exactness. It is significant that his first patent was in that direction, for mechanical accuracy became one of the major factors in his great success as well as a deeply rooted phase in his character. He commenced early in his career to pay special attention to the subject of gearing. Besides the epicycloidal milling machine, he invented a new gear cutting machine for generating and at the same time cutting the teeth of the spur gears. Many other patents followed, the majority of them for turret

machines and optical sighting instruments. Today an important division of Mr. Swasey's achievements is the design of military instruments of precision, including the invention of the depression Position Finder for seacoast defense fortifications, used by the United States Government for a number of years.

In his scientific writings one may easily see his profound understanding of the evolution of thought in mechanical engineering as well as astronomical technique.

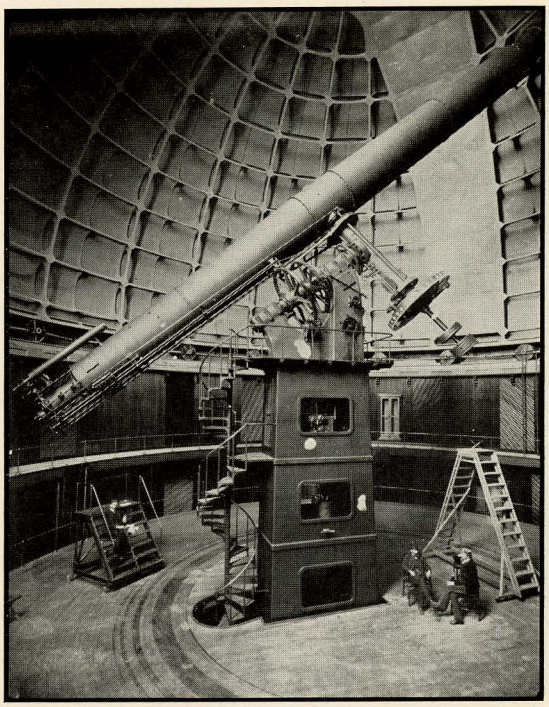
The Cleveland Firm

In 1880 Warner and Swasey left Hartford to enter business for themselves having for capital, eleven years of joint savings. Their first location was in Chicago, but later they felt this was too far removed from the industrial east, and they decided to move. On July 8, 1881, there came to Cleveland a new citizen, a young man with a striking face, beaming eyes and the picture of health, Ambrose Swasey, the machine tool builder. His partner had left Chicago some months earlier to supervise the construction of the shop they had planned for this city.

There was little difficulty in obtaining orders and the new firm concentrated on a policy of establishing the highest standards in their products, whether in machine tools, instruments of precision, or telescopes. The two men were so absorbed in the designing and making of machines, and the trust in each other was so great that they did not bother to draw up a written agreement of partnership until 1900 when they incorporated as the Warner and Swasey Company.

Early Astronomical Work

Astronomy had been the delight of Worcester Warner since early youth. His interest inspired his young friend Ambrose and soon this subject became an added bond between them. They had talked and thought and built small instruments for many years. It is not difficult therefore to understand that soon after they had established themselves in business, they had designed a distinctly improved mounting. This first telescope, a nine and one-half inch refractor, was sold to Beloit College upon the recommendation of Professor Burnham. A year later in 1882, they



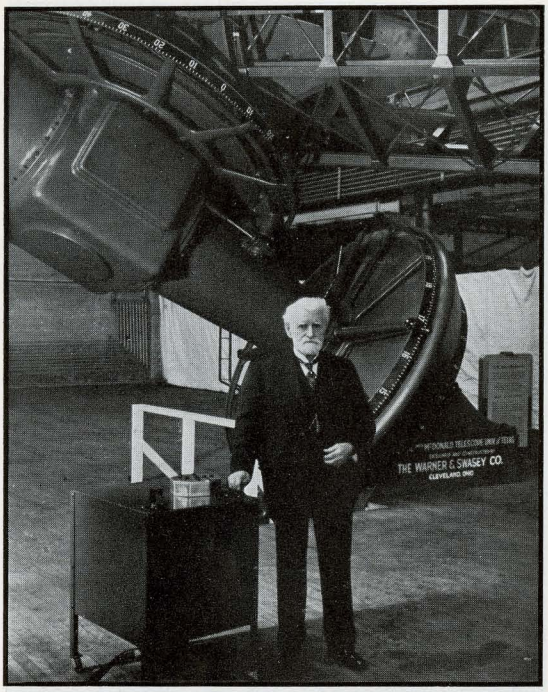
An early photograph of the Lick telescope showing Professor Keeler (on the observing chair), Mr. Swasey, and Captain Floyd.

constructed their first big dome, forty-five feet feet in diameter, for the Leander McCormick Observatory of the University of Virginia.

The tremendous progress in telescope making may be realized when we recall that the largest telescope in the world in 1845 was a fifteen-inch refractor. Harvard College and Pulkowa each shared the honor of such a telescope. The race for larger instruments may be said to have commenced about that time. The two young partners had much to do in bringing America to its undisputed supremacy.

Lick Telescope

When the Lick trustees were preparing for the largest and most powerful telescope in the world, according to the wishes of James Lick, plans and bids were asked for the mechanical parts from all the telescope makers of the world. This was taken as a challenge by the two visionary and energetic manufacturers. Their knowledge of astronomy was limited and their experience in telescope making went not further than the nine and a half inch instrument for Beloit College. This new venture was a problem of the first



Mr. Swasey on his eighty-ninth birthday, with the eighty-two inch MacDonald telescope mounted in their shops.

magnitude even for the most experienced engineers in this field. The undertaking called for an instrument to be used not only for visual work but photographic and spectroscopic as well, new functions at that time. With their characteristic thoroughness and team work, the two partners in a few months submitted plans and theirs was the highest bid submitted. The design in which they included for the first time polar and declination axes of steel, ball bearings, and improved counterbalancing was judged to be the best, and it received the award.

On November 14, 1887, a year and a half later, Mr. Swasey left Cleveland for California to supervise the erection of this magnificent instrument. On December 31, Alvan Clark placed his masterpiece, the thirty-six inch objective, in the tube of the telescope. The astronomical career of the Lick telescope began on January 3, 1888, when Captain R. S. Floyd, president of the Lick trustees, Alvan Clark, J. E. Keeler, and Swasey observed through it, first Aldebaran and later the Great Nebula in Orion.

Period of Large Telescopes

Soon after the completion of the Lick telescope came the building of the new mounting for the twenty-six inch refractor and the meridian circle for the United States Naval Observatory.

When in 1892 the forty-inch Yerkes was projected there was no doubt as to the style of mounting, nor as to the makers. They received the contract for the telescope and the ninety foot dome without competition. The result was this world famous instrument which combines beauty and precision, strength and delicacy of motion, characteristics close to the heart of its designer.

The trend in astrophysics, particularly at the beginning of the century, brought reflecting telescopes into great prominence and Ambrose Swasey took an active part in their design and construction. It was his engineering genius that made possible the improvement in the mounting of the secondary mirrors which enables one to change from the Newtonian to the Cassegrain arrangement with little danger or loss of time. This was first done for the seventy-two inch reflector of the Dominion Astrophysical Observatory.

The completion of the mounting for the eighty-two inch MacDonald telescope coincided with his eighty-ninth birthday and it was very evident at that time that he was proud to see that the men whose skill he had helped develop were doing such creditable work.

For over eighty years the work of the construction of large telescopes and the figuring of their optical parts has been done in America. The only non-American feature which astronomers in this country needed was the glass from which lenses and mirrors are made. Ambrose Swasey felt that the United States should be able to make such glass at least for large mirrors and spoke to Herbert Hoover, then Secretary of Commerce. He suggested that the Bureau of Standards might undertake to furnish a sixty-inch disk for the Perkins reflector. After a number of unsuccessful trials, the Bureau finally produced in 1923, a sixty-nine inch disk, the first large disk made in America.

Dividing Engine

Last May Mr. Swasey was asked, "What in your opinion is the greatest thing you have done?" All at once his eyes sparkled, his face

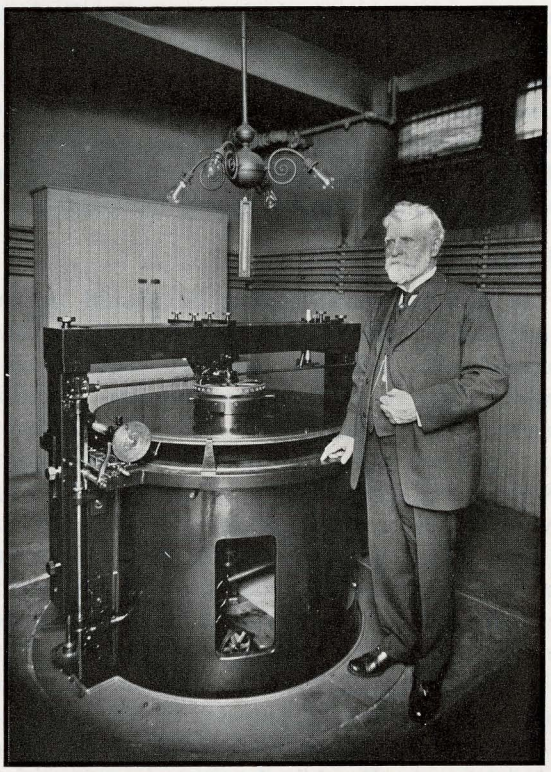
brightened more than ever, and it seemed that a war veteran was getting ready to describe a famous battle. "The highest type of construction and piece of work I ever did," he said, "was the dividing engine. When you can take a spindle four inches in diameter and about twenty-five inches long with five-eighths inch taper to the foot and make that spindle fit into a bearing easily and when you drop it a thousandth of an inch it goes hard, you are getting down to a refinement about which we knew nothing in those times. Dividing engines had all fallen down on the spindle—could not get a spindle in the bearing that would fit." The dividing engine was built primarily for graduating circles of astronomical instruments used for fundamental star work as well as for instruments in geodetic surveying. It has an error of closure of one second of arc and required three years in building. It was fortunate that during this period Mr. Swasey had with him the most able assistance of Mr. G. Fecker the talented optical expert.

The joy of working for and attaining accuracy in machines was an inborn characteristic as it is in many of our greatest scientists. To construct a machine as accurately as is humanly possible to do and to make it durable, beautiful and practical was the motive power of his great career. This aim is evident in all he has done, in planning a building for some college campus, in the establishment of a Foundation or in building a telescope.

Engineering Foundation

Mr. Swasey has taken an active part in the foundation of the American Society of Mechanical Engineers and in 1904 served as its president. His interest, however, extended to other engineering and scientific societies.

His association with scientists and engineers strengthened his belief in the value of research to engineers and industry and at the same time, he perceived that its importance was not sufficiently apprehended. Realizing the need, he conceived, and in 1914 established the Engineering Foundation for the furtherance of research in science and engineering, or for the advancement in any other manner of the profession of engineering and the good of mankind. This was the first known instance of a Foundation devoted primarily to engineering purposes. His gift amounting to three-quarters of a million dollars has contributed in many ways to the advancement of the profession which was so dear to him and made possible the initial organization of the National Research Council. The activities of the Foundation were wisely and broadly planned, to be readily adaptable to the varying needs of the profession. The Foundation well expresses the deep interest of Mr. Swasey in things which upbuild and endure.



Mr. Swasey with the dividing engine which in his opinion was his greatest engineering achievement.

The Builder of Men

We need but contemplate the fine machines and astronomical instruments which his firm built to realize that Mr. Swasey's inventive and mechanical genius as well as his love of precision and artistic design contributed greatly to his successful career. He was able to recognize greatness and nobility in men and to choose his friends wisely; they enriched his life as he enriched theirs. We find among his astronomical friends

such men as John A. Brashear, Alvan Clark, Simon Newcomb, Asaph Hall, Edward Pickering, C. A. Young, J. E. Keeler, S. W. Burnham, and E. E. Barnard. "These men stand out as first magnitude stars in the realm of astronomical science, and to have had some part in their great work for science and humanity is indeed glory enough and compensation enough."

Another factor which contributed to his success was his ability to select capable young men and systematically to train them. He and his partner were among the pioneers in establishing an apprentice school which goes as far back as 1880. "They call this the age of metals and machinery," Mr. Swasey used to say, "but the time will never come when the world will not need fine men more than it needs fine machinery." Toward this need he worked as assiduously as he did in building machines and telescopes.

Honors

It was but natural that he should be the recipient of many honors both at home and abroad. He held six honorary degrees, and membership in many engineering and scientific societies, including the National Academy of Sciences and the American Philosophical Society. He was a Fellow of the Royal Astronomical Society and Officier of the Legion of Honor (France). He was awarded numerous medals. In 1924, in recognition of his many contributions to the development and progress of engineering, Mr. Swasey received the John Fritz Gold Medal, the highest honor bestowed by the engineering profession in this country. In 1932, he was awarded the Franklin Gold Medal by the Franklin Institute in recognition of his development of methods and his invention of appliances for making machines, instruments of precision and mountings for large telescopes.

He deeply appreciated the honors he received and in a way enjoyed the ceremonies which were inevitable upon such occasions, although he accepted them with respect and modesty. He wished to say, "It is a great privilege to be counted among the distinguished men of science whom you have already honored. I thank you for the joy that you have so graciously given me."

The following short narrative illustrates his modesty. When once Mr. W. H. Croker of San Francisco remarked, "Why, Mr. Swasey, you are an astronomer." He replied, "When I was a boy, my father kept a great number of sheep and when working around the barn and with the sheep, some of the wool rubbed off on me, but that didn't make a sheep of me. In later years, I have been working with scientists and astronomers and rubbing up against them, but it takes more than that to make an astronomer."

It was a source of great pleasure to Mr. Swasey when on his eighty-eighth birthday, Dr. Otto Struve announced the naming of Asteroid 922, "Swaseya." Dr. Struve's discovery of the asteroid was made on November 14, 1922.

Private Life

Mr. Swasey was married in 1871 to Lavinia Marston who came from his own New England state of New Hampshire. She was reserved, gracious, and deeply religious, much like her husband. At their home in Cleveland, they lived quietly with but little entertaining which was mostly restricted to out of town guests. There were no children. Mrs. Swasey died in 1913.

He traveled extensively at home and abroad, went around the world twice, and in 1917 for the third time visited China where for many years he had been interested in the collection of old coins and in promoting higher education. As an expression of his deep interest in Chinese education he provided funds for the erection of the Canton Christian College Y. M. C. A. building and the Science Hall at Nanking University.

His life long interest in architecture and his love for the beautiful contributed materially to the architectural design of many college buildings for the erection of which he gave the funds.

His interest in engineering and research, in higher education, and in the Baptist church are well expressed by his generous contributions.—"Whatever success I have had," he used to say, "which enabled me to make these gifts, I owe not to myself but to the fact that I have had a good mother, a good wife, and a good partner in business."

His unusually robust constitution kept him active until the end. Only last summer he paid a short visit to his friends in England. On the occasion of the presentation of the Hoover

Medal in December last, he took his full share in the ceremony, including a short speech of acceptance. In April he attended the meeting of the National Academy of Sciences in Washington.

On May 21st, a cold confined him to his Cleveland home but his strength was now rapidly failing in spite of his great will to live. On June 9th, upon his insistent request, he was taken to his native home in Exeter. The end came a week later.

His active life covered nearly three-quarters of a century. His achievements in his chosen field and his influence for good have made us all the richer. We may well rejoice that his noble life coincided with part of ours.

Case School of Applied Science,
June 24, 1937.

The importance of advanced education for leadership in business is indicated by a recent survey reported to the Society for the Promotion of Engineering Education, which showed that out of 15,084 college-educated officers of American industry, including presidents, treasurers, and executives in engineering, sales and production, 12,225 were graduates of engineering and scientific institutions, and 2,859 from all other types of colleges. Of the 235 college-trained presidents in American industry, 151 were educated in technical and 84 in other educational institutions.

KARL T. COMPTON