with words and it is healthful and helpful to study the life and work of such engineers as excite our respect and admiration. All men have faults, but if we look for the good in them, we find inspiration and instruction to aid us in striving for the ideal we have adopted, and if we study enough examples we may construct a composite ideal combining the admirable qualities we have observed in many men, and if in addition we have selected our examples from among those who have passed from us into another world, we have no occasion even to remember such faults as they may have possessed. Study our list of members and you find scores of names among the living and dead, whose personal qualities and professional attainments ennoble the profession. It is not fitting in this connection to mention names of living members and I hesitate to select names from among our honored dead, lest in my imperfect knowledge of their virtues I may not arrange them in their order of merit, but as I write this there comes to me the memory of Pope, Parkhurst, Dun, Lassig and many others to whom I have been indebted for their influence and example. I call to your attention another example by quoting from recent Chicago newspapers. A telegram from Gary, Ind., reads:

"When Harry N. Atwood passed over the sand dunes near Miller, Ind., he gave the natives a view of modern aviation. They were well acquainted with antiquated aviation, for Octave Chanute, the father of aviation, made his first flights in that locality in 1896. Work in the steel mills was practically suspended in Gary and scores of locomotives and the steel company's whistles heralded the approach and passing of the aviator."

Another newspaper in an editorial, referring to the great aviation meet in Chicago in August of this year, states:

"There probably will not be a contestant in the events who will not turn his thoughts back to the days only a few years in the past when Octave Chanute, a Chicago engineer, was conducting aeroplane experiments on the

shore of Lake Michigan, only a few miles from Grant Park. Every man who guides a machine in its flight will be willing to acknowledge that to Chanute more than to any other man belongs the credit of making flying possible.

"The debt to the Chicago experimenter has been acknowledged by most successful aviators. In every machine which will start upward from Grant Park at the aviation meet there doubtless can be found substantial evidence of the constructive genius of Octave Chanute. He lived long enough to see the practical application of principles which he had formulated.

"Fifteen years ago aeroplanes were tested in the sand dunes region of Northern Indiana. The experimenters had the wings and the tail of the bird-like machines, but could apply no motive power excepting that which a fair running start down a hill could generate. The 'landing' invariably was a wet one, for the end of the journey was the lake. There probably would be no meeting of aviators one week from Saturday if Octave Chanute and a few other men had not been willing to face ridicule in the effort to learn the secret of the mastery of the air."

Octave Chanute was one of the best friends this society ever had, and likewise a friend and encourager to each of our members who enjoyed his personal acquaintance. He was a persistent seeker of fundamentals and I advise all who have not done so to read his memoir, published by this society, and to profit by his example. Indeed, I think a condition should be attached to the award of the Chanute prizes—that the recipient should read this memoir.

We hear much in these days about a broader education for engineers. The subject is frequently mentioned among those who, in the course of their practice, have learned the necessity for breadth of vision and action, and I think practicing engineers will generally agree with me that this lack of breadth is a real weakness in our present make-up. The universities are consider-

ing the subject with a view to providing a remedy for this weakness, but the professors and graduates sometimes make the mistake of assuming that engineers are made at the universities. The education of an engineer is neither begun nor ended in the schools; the university cannot make an engineer; it cannot even give him an engineering education. It can only partially equip him for his journey through life. He must find his own way across the rivers and over the mountains, learning how to overcome the dangers which confront him; to make use of the favorable features of topography, and to find pleasant camping places as he travels. The engineer's education is never completed. This would mean that he knows and obeys all of the laws of Nature and man, which is reducing the proposition to an absurdity. The very fact that he must be a learner all through his life is the chief charm of his occupation. What he accomplishes on his journey and where he finally ends must depend on himself. He will be a successful engineer if he leaves a record of useful work and if his own life and the lives of others which come in contact with his own are made happier and better.

He must be a man among men of all occupations, making himself a useful citizen and an agreeable member of the society in his community, increasing his opportunities for helping others and by making his own self and attainments known to them, enlarging his circle of professional clients. He should recognize his obligation to the commonwealth and should respond to its calls for duty. Such calls for advice and assistance frequently go begging without response, losing at the same time chances for securing recognition of the profession. Because engineers build railways and power plants and other utilities, there is no reason why they should not take their places as good citizens, interested in and assisting in every good work intended to better the conditions of their race.

All of this he will accomplish if he strives for the right ideal and builds on the proper fundamentals.

A Flying Laboratory

The Observatory on Board the Schwaben

THAT practical genius of the Germans which causes the prompt transmutation of newly discovered scientific truths into terms of concrete utility has just received a fresh exemplification at the instance of Director Colsman of the Zeppelin construction and transportation companies.

Under his orders the magnificent new airship "Schwaben" has had partitioned off from one end of the passenger-cabin a small room elaborately fitted with appliances for the making of scientific and technical experiments while *en route*, in other words a "midair laboratory."

The improved manner in which dirigibles are now operated insures flight as a rule over a definite course and at a fairly constant altitude. Such comparative uniformity of conditions permits the keeping of an aerial log, and the determination of various problems in regard to the various factors, internal and external, which affect flight. The midair laboratory offers advantages for the study and solution of such problems, obviously superior in many important respects to the facilities provided on *terra firma* either in workshop or in the university, since the investigator is in a position constantly to "check" his preconceived theories by the observation of actual facts.

The passenger-cabin on the Zeppelins is built upon an enlargement of the gangway running between the rear and forward gondolas. On the "Schwaben" the laboratory is a small but comfortable room communicating with the cabin by a door and containing a single one of the seven windows visible from the outside. The floor-space is about 100 square feet, and a photograph of the interior shows not only scientific instruments, but a comfortable easy chair, and the tap of a water-tank with a porcelain sink beneath.

Remarkable success of construction has been attained, as proven by the fact that the familiar disadvantages of dirigible travel, the noise of motors and propellers, the strong draught, and the vibration, have been almost entirely eliminated. Moderately sensitive instruments, such as galvanometers and electrometers can be used without precautions, and telephone sounds can be heard plainly without covering the free ear, while mere whispers can be detected with the free ear closed.

It is to be expected that this laboratory will throw light on a great variety of questions, meteorological and otherwise, such as the effects of sunlight, of warmth and humidity, the variations of wind-pressure, and direction of air currents, but its chief aim at present is the investigation of atmospheric electricity and wireless telegraphy, with special reference to the use of the latter as a means of directing the airship by night or in thick weather.

As respects the former, it is of special importance to learn how such a great airship is affected as it passes through the local magnetic field, and the inherent possibilities of receiving or giving off an electric charge. Prof.

Dieckmann, an authority on these subjects, says, "Conditions in this connection are not so simple as has been hitherto supposed. Among other things a complication appears to arise from the fact that the exhaust gases of a gasoline motor leave the exhaust charged positively and the airship negatively. At the same time the exhaust gases effect an increased conductivity of the air."

The apparatus used in these experiments is very simple, consisting of an "equalizer" fixed to the body of the aircraft, and projecting on rods into the air above and below, these of course being carefully insulated. The "equalizer" consists merely of a plate of platinum covered with radium, and this little "equalizer" quickly takes the potential of the surrounding space. The differences of potential are then read by means of the electrometer. These differences are by no means small, for the "equalizer" underneath the ship often runs as high as 1,000 volts per meter.

The overhead differences run much smaller, so much so that there is practically no danger of a spark. By a similar simple device, the "storm-indicator," the observer is warned of abnormal electrical conditions in the neighborhood of the ship at any portion of its course.

The experiments with wireless telegraphy in the flying laboratory are even more interesting and important. They have two main objects, the sending of meteorological advices, or weather-warnings, and the elaboration of a definite system for indicating the direction of movement through the air, so that in rain, mist, fog, or starless nights the pilot may be able to find his bearings and keep to his course.

Such a system has already been worked out and was successfully employed in a flight made last August.

The principle is exceedingly simple, and may be stated as follows: The energy radiated from any wireless sending station calls forth a response at any given receiving station directly proportional in strength to the distance of the latter. The receiving of messages, however, is usually by the ear; consequently the distance is directly proportional to the loudness of the sound. The comparative loudness of the sound is measured by an ingenious little device called a distance meter. This consists merely of an ordinary instrument for measuring electrical resistance, connected in parallel with the telephone, and provided with a linear scale in which zero stands for the point at which sounds cease to be audible. The divisions of the scale indicate the intensity of sound at given distances. If now not less than three land-stations using the same wave-length send signals to the airship, one after the other at brief intervals of time, the spatiometer will show the distance of each station and likewise their relative distance. By consulting a chart it is very easy to calculate from these data the latitude and longitude of the ship, and likewise by repeated measurement both the

speed and the course of the dirigible may be determined.

In this connection Prof. Dieckmann mentions an automatic arrangement for indicating direction of movement already in operation at Gräfelfing, near Munich. Each of four sending-stations, 1, 2, 3, and 4, located at the corners of a square, has a prescribed sending time. "Each station sends its place-signal every five minutes for a period of one minute's duration, so that a balloon or an airship receives them in rotation at intervals of about 15 seconds, and can determine the relative intensity of sound."

We shall await with interest future developments of this novel installation of a working laboratory in a swiftly moving airship.—*Abstracted from Prometheus.*

Social Equilibrium.—It is commonly understood that there is some natural law which governs the distribution of the wage earners in each country over the several professions and callings which are open to the individual. Fundamentally, of course, the law at work here is one of demand and supply, though its detailed mode of working is not very easy to realize, for, while it is obvious that an urgent demand will cause an appreciable rise in the remuneration offered in the particular field in question, slight fluctuations in demand would, at most, cause only slight increase in the payment offered, and it is not quite easy to see how the average individual becomes aware of such slight fluctuations, so as to take advantage of them. On the other hand, it may presumably be taken for granted that excessive fluctuations rarely or never occur, so that somehow or other the balance is maintained without allowing any critical conditions to arise. It is interesting, in this connection, to observe some actual figures relating to the distribution of the population among different occupations in the United States in the past, as set forth in the Statistical Abstract of the United States, published in 1909. The table which is given below shows the distribution in percentages of the male population over ten years of age, engaged in a number of specified occupations. An inspection of these figures will show that while certain changes have occurred which are not by any means negligible, yet the general balance has been essentially unchanged.

	1890.	1900.
	Per cent.	Per cent.
Agricultural pursuits	41.6	39.6
Professional service	3.4	3.5
Domestic and personal service.	13.6	14.7
Trade and transportation.....	16.4	18.0
Manufacturing and mechanical pursuits	24.7	24.3

Fig. 1.—Bronze Containing 10 per cent Tin, in the Strained Condition. Magnified About 85 Diameters.

Fig. 2.—The Same Specimen as Fig. 1, After Annealing. Note Large Regular Crystals. Magnified About 85 Diameters.

Fig. 3.—German Silver, Containing About 63 per cent Copper, 18 per cent Nickel, 19 per cent Zinc. Strained Specimen, Magnified 85 Diameters.

The Crystalline Constitution of Metals

The Influence of Annealing on Crystalline Structure

By Thomas A. Eastick

WITHIN recent times the search for metals and alloys having the requisite properties to fit them for the varied and complex uses of modern engineering practice, has become very keen and has also helped to build up a new science, a science, too, which is unique in its practical utility. It is known as metallography.

It is quite a common thing among laymen, and even among some engineers, to regard metals and alloys as

of the constitution of metals is to be found in the works of Robert Hooke, published in 1665; Hooke describes the crystallization of lead from its alloy with silver with remarkable clearness and accuracy.

Reaumur in 1722 used to examine the structure of iron and steel with the microscope regularly, and made some very sagacious remarks on the influence of thermal treatment on the form and size of the crystals.

H. C. Sorby of Sheffield, England, however, is regarded as the founder of metallography and he published between the years 1865 and 1885 numerous papers and micro-photographs, some of which were beautifully executed, on the constitution of iron and steel.

After Sorby came numerous workers; Martens published some excellent results from the Charlottenburg laboratories; Charpy Osmond and LeChatelier, in France, contributed greatly toward the advance of the science by devising new apparatus and methods of examination.

While the microscope and photography are the two chief servants to metallography, there are, of course, a great many other branches and considerable theory is used in conjunction with the micro-photographs to solve the numerous problems met with in the examination of metals.

When a metallic substance is under examination, the first determination that is made is the cooling curve. If we take an absolutely pure metal and melt it, and then allow it to cool and take the temperature, say, every minute, and then plot the results, we obtain a curve similar to *a* in the chart. It will be noticed that there is a very perceptible break in the curve about half way down. This break is due to the metal solidifying, as when we melt or freeze water the temperature remains stationary until all the water is either frozen or melted.

This type of curve shows that the metal under examination is either a pure metal, a eutectic or a solid solution.

Here we have two new terms, "Eutectic" and "Solid Solution," which need explanation. It has long been known, almost common knowledge in fact, that when two or more substances are mixed together the mixture will have a considerably lower melting point than

Chart of Cooling Curve. Note the Kinks, Which Correspond to Solidifying Points.

either of its constituents. And there is a certain mixture, of course, in the series which will have a lower melting point than any other mixture, this mixture is the eutectic.

In the alloys of gold and thallium, for instance, the alloy consisting of 77 per cent thallium and 23 per cent gold will melt at a temperature of 125 deg. Cent., whereas the melting point of gold is 1,100 deg. Cent., and that of thallium about 300 deg. Cent. This alloy

Diagram Showing Condition of Lead-Antimony Alloys at Different Temperatures.

being amorphous, homogeneous masses of matter having those distinctive metallic properties such as hardness, toughness, malleability, etc. That such is not the case, however, is now very well known to scientists. Practical metallurgists have, in fact, applied the principles of metallography and the microscopic examination of metals to practical purposes with extraordinary success.

One of the first notices that we have on the subject

Fig. 4.—The Same Specimens as Fig. 3, After Annealing. Note the Clearly Defined Crystals, Magnified About 85 Diameters.

Fig. 5.—Tin-Zinc Alloy, as Cast. Shows the Characteristic Round "Grain" of Unannealed Cast Metals. Magnified 85 Diameters.

Fig. 6.—Ingot Copper (Electrolytic Copper Recast). Crystals of Copper Enclosed in Eutectic of Copper and Cuprous Oxide. 180 Diameters.