recommendations with this end in view were made. The committee is in agreement that the time is ripe for the promotion of close relationships between these two fields of knowledge. The committee was authorized to coopt three members in the social and economic sciences within the Pacific region.

6. The Xi Sigma Pi Forestry Fraternity was received into membership as an associated society.

7. The Academy of Science of St. Louis was elected an affiliated academy.

8. Resolutions adopted by the Southwestern Division of the American Association at its eleventh annual meeting were received.

9. T. H. Morgan, president of the American Association, was appointed by the chairman to be the representative of the American Association for the Advancement of Science at the inauguration of Robert Gordon Sproul as president of the University of California.

10. The appointment of a representative to the advisory board and council of the Association of International Patentees was deferred pending the receipt of further information.

11. J. C. Merriam was appointed to represent the American Association for the Advancement of Science on the council of the National Parks Association.

12. The election of a permanent secretary to succeed Dr. B. E. Livingston was considered at length. The chairman reported that 144 nominations had been received. Although a preliminary selection of candidates was made, it was agreed that final action must await the settlement of several questions pertinent to the organization and work of the association. There is the possibility of reorganization along regional lines, in the event of which several part-time secretaries would be required. The nature of the responsibilities and duties of the permanent secretary, the desirability of part-time or full-time service, the location of the association headquarters and other related matters require decision before an election is made.

13. The third week of June, 1931, was approved as the time of holding the Pasadena meeting, unless the local committee should regard the fourth week as preferable. The duration of the meeting was left to the decision of the executive committee of the Pacific Division, which, with the local committee, was entrusted with the arrangements and organization of the meeting.

14. On nomination by Walter S. Adams and R. A. Millikan, the executive committee of the Pacific Division elected the following as members of the local committee for the Pasadena meeting:

Paul Merrill, *chairman*, Mount Wilson Observatory.
H. D. Babcock, Mount Wilson Observatory.
John P. Buwalda, California Institute of Technology.
E. C. Watson, California Institute of Technology.
Linus Pauling, California Institute of Technology.
R. O. Schad, Huntington Library and Art Gallery.

15. The committee adjourned to reassemble in October or November at the call of the chairman.

J. MURRAY LUCK, *Secretary,*
Pacific Division

THE NATIONAL ACADEMY OF SCIENCES

AT the autumn meeting of the National Academy of Sciences, held in California from September 18 to 23, the following papers were presented at the meetings held at the University of California and the California Institute of Technology:

Design problems of the Golden Gate bridge: CHARLES DERLETH, JR. (introduced by A. O. Leuschner). A century ago suspension bridges were built with iron chains. Vertical suspenders supported the floor and live load. In 1816 Telford built the Menai Bridge with a 580–ft. span. The bridge over the Danube at Budapest had a 666-ft. span; the Clifton Bridge near Bristol, England, a 702-ft. All had iron chains. The first iron drawn wire cable was introduced in 1816 by White and Hazzard for a foot bridge across the Schuylkill at Philadelphia, span 408 ft. Since then there has been gradual development using straight wire cables. Long spans soon were built in America at New York, Niagara Falls and across the Ohio. Until recently the maximum spans did not exceed 1,600 ft. Modern erection methods, the introduction of the deflection theory, improved devices for cable spinning, etc., have made possible great openings. To-day a 3,500-ft. span is building across the Hudson River and one of 4,200 ft. has been designed for the Golden Gate at San Francisco. Rankine in England and Ritter in Switzerland developed the rigid stiffening truss assuming that the suspended truss remains absolutely rigid under live load, the original cable curve being undisturbed. The assumption involved the elimination of dead load stresses in the stiffening truss. As spans increase, the error of this assumption is serious and uneconomic. For long spans a stiffening truss of reasonable proportions becomes increasingly flexible, changing the shape and deflection not only of the stiffening truss but also of the cable. These distortions can not be neglected. The cable, suspenders and stiffening truss constitute one composite elastic structure. Distortions of one part affect the stresses in all the others. The cable is the most rigid member. The stiffening trusses relatively are slender. Therefore any change in shape of the cable curve causes the total cable tension to affect the stiffening truss. Thus the dead loads in the cable tension introduce stresses due to dead load in the stiffening trusses. In

the design of long-span bridges in recent decades, the deflection theory has shown that by its application marked economies can be introduced. The elastic theory of Mueller-Breslau and Melan no longer is applicable. When applied, the elastic theory gives stresses which are incorrect and much greater than they should be.

The earthquakes of November 28, 1929, and the surface layers of the earth in California: PERRY BYERLY (introduced by A. C. Lawson). On November 28, 1929, at about 11h. 49m. A.M., P.S.T., the west central section of California and the neighboring portion of Nevada was shaken by an earthquake which reached an intensity of VII on the Rossi-Forel scale near Aberdeen, California. A study of the records of this earthquake from eleven stations in California and Nevada has been made. The epicenter was placed at 37° 31′ North Latitude, 119° 02′ West Longitude. The time of occurrence was 11h. 48m. 52s. This epicenter is consistent with the area in which the earthquake was felt since it is near the center of that area although it is not at the point where the greatest intensity was reported. It is consistent with the directions from the three of the nearer stations as given from the first arriving longitudinal wave. However, the direction method in this case is open to some error. This epicenter allows a reasonable explanation of the travel time curves and was adopted after many trials. The arrival times of the various waves at each station were plotted against the epicentral distance of the station. It was found that straight lines could be drawn through the points and the waves explained as has been done in Europe. More than one set of longitudinal waves were observed as well as more than one set of transverse waves. In this interpretation there are recognized (1) the direct longitudinal wave in the upper or granitic layer ($v = 5.8$ km/sec), (2) the longitudinal wave along the surface, set up by the incidence on the surface of the transverse wave from the focus ($v = 5.5$ km/sec), (3) the longitudinal wave which has penetrated the intermediate layer ($v = 7.4$ km/sec), (4) the longitudinal wave which has penetrated to the underlying medium ($v = 8.6$ km/sec), (5) the direct transverse wave ($v = 3.3$ km/sec), (6) a later wave probably of surface type ($v = 3.2$ km/sec), (7) the transverse wave which has penetrated to the underlying medium ($v = 4.6$ km/sec), (8) a wave arriving between the two general groups of primary and secondary types; the position of its travel time curve suggests that this wave may have its genesis in the incidence on the surface of the longitudinal wave which has penetrated the intermediate layer ($v = 3.4$ km/sec). A second earthquake, apparently from the same focus, occurred some three minutes later. Although its beginnings are somewhat obscured by the first earthquake its travel time curves as observed are consistent with those of the first shock. The difference in the time intercepts of the waves of types (1) and (2) above gives a depth of focus for this earthquake of about 4 kilometers. The positions of the curves of waves (1), (3) and (4) lead to values of the thicknesses of the layers. It is concluded that the thickness of the granitic layer under this Sierran region is about 30 kilometers. The thickness of the intermediate layer is about 35 kilometers. The writer has recently obtained values for the surface layers under the Pacific. These would indicate that the Pacific region is not in isostatic balance with the Sierra region. It is possible that the region has not yet had time to attain this balance.

The dynamic effects of earthquakes on engineering structures: LYDIK JACOBSEN (introduced by W. F. Durand). Since 1927, a special type of vibration research has been carried out by the School of Engineering at Stanford University. The object of the investigations is to study the dynamic behavior of structures subjected to definite types of ground vibrations, especially those resembling an idealized horizontal component of the earth motion occurring during an earthquake. For economic reasons it is not feasible to make full scale structures and to provide for their adequate testing apparatus. A program involving experiments on models of common types of building construction is therefore being undertaken by means of a nine by twelve feet structural steel platform mounted on street car wheels. The platform or table is capable of executing, simultaneously or independently, two types of motion in one direction, namely, a steady, forced, harmonic vibration, and a transitory, free, harmonic vibration. The paper contains a short description of the vibrating table and a summary of the problems that are being investigated by the mechanical equipment. The question of dynamic similitude has been given attention from the experimental side; thus, models of two simple structures have been built to five different scales of the linear dimensions, ranging from full scale to one quarter scale.

The pressure of the wind on large chimneys: HUGH L. DRYDEN and GEORGE C. HILL (introduced by George K. Burgess). The practical problem of determining the wind pressure to be used in the design of a large chimney requires for its solution the determination of the variation of the wind pressure on a cylinder with the size of the cylinder and the speed of the wind. This task is a very interesting scientific problem, since experiments on the largest cylinders (8 to 12 inches in diameter) which can be used in wind tunnels show that the wind pressure on a large cylinder is very much less than that which would be obtained by increasing the pressure on a small cylinder in the ratio of the exposed areas. It is found necessary to supplement experiments in wind tunnels by experiments on large cylinders in natural winds. Measurements in natural winds have been made on an experimental stack ten feet in diameter and thirty feet high erected on the roof of the West Building of the Bureau of Standards. Pressures were measured at twenty-four stations around the circumference at a single elevation, about two thirds of the height from the base of the stack. The wind speed was determined by means of a pitot-static tube mounted on a weathervane about ten feet higher than the top of the stack. A method for determining the wind speed from the distribution of the pressure has been developed and the results have been compared with the direct mea-

surements. The method assumes that the static pressure is equal to the observed pressure on the cylinder at a certain zonal angle determined by extrapolation of data obtained in wind tunnel tests. Direct measurements of the overturning moment were obtained by mounting the stack on pressure capsules. The value of the average wind pressure determined from the overturning moment is somewhat higher than the value determined from the pressures at a single elevation. The pressure distribution at a single elevation was also measured on the power plant stack of the Bureau of Standards. The general conclusions drawn from the tests are as follows: (1) The wind pressure on a chimney at a given wind speed is a function of the ratio of the height of the chimney to its diameter and possibly also of the roughness of its surface. (2) Experiments on small cylinders can not be directly used to predict the wind pressure on a full scale chimney because of the large scale effect. (3) A wind pressure corresponding to 20 lbs. per square foot of projected area at a wind speed of 100 miles per hour is a safe value to use in designing chimneys of which the exposed height does not exceed 10 times the diameter. (4) The pressure may reach large values locally and this may need consideration in the design of thin-walled stacks of large diameter. (5) Further experiments are necessary to obtain satisfactory information as to the variation of wind pressure with the ratio of height to diameter. A full account of the work is given in Research Paper 221 ("Wind Pressure on Circular Cylinders and Chimneys," by Hugh L. Dryden and George C. Hill) appearing in the September, 1930, issue of the Bureau of Standards *Journal of Research*.

Circulation of the waters of the Pacific Ocean as indicated by their physical and chemical properties: E. G. MOBERG (introduced by T. Wayland Vaughan). The circulation of the water in the open ocean, especially below the surface, can not be measured by direct methods but is deduced from the variations in the physical and chemical properties of the water. By such means it has been found that most of the deep water in the Atlantic is derived from the surface, the sinking of the water taking place in the north central part of this ocean. A considerable amount of water enters the Atlantic from the Antarctic and moves in two layers, one immediately over the bottom and the other at a depth of about 1,000 meters. A current system similar to that in the Atlantic has been found to exist in the Indian Ocean, and prior to the last cruise of the *Carnegie* it was thought that the circulation in the Pacific resembled that of the other two oceans. The temperature and salinity data obtained by the *Carnegie* indicate no important amount of sinking of surface water in any part of the Pacific and the relatively high temperatures at great depths show that no appreciable quantities of water enter the Pacific directly from the Antarctic. Furthermore, it was found that the deep water in both the North and the South Pacific has a remarkably low oxygen content which is incompatible with the theory that this water is derived either from the surface or by a direct route from the Antarctic. It is probable that most of the water of the Pacific enters south of Australia from the Indian Ocean where is it formed by the mixing of water returning from the northern part of this ocean with water from the Antarctic.

On the favorable action of certain fats and of the glycerides of certain single fatty acids on animals deprived of vitamin B: HERBERT M. EVANS and SAMUEL LEPKOVSKY. The addition of fats to a sugar-casein diet, as we have already shown, acts to spare body requirements for the antineuritic vitamin B. The attention of nutrition students can not fail to be attracted by the fact that in spite of the complete withdrawal of B, the inclusion of 50 per cent. fat in such diets enables animals to achieve considerable growth and to survive for many months. Controls die within a month. Though the ultimate growth and survival periods are both lessened, 25 per cent. fat also bestows favorable effects on animals deprived of B. The effect is slight with cottonseed oil (Wesson oil) and only slightly better with lard, but is marked with cocoanut oil, whether natural or synthetic. (Synthetic cocoanut oil was prepared by saponifying cocoanut oil, collecting the fatty acids, washing, distilling and finally esterifying them with freshly distilled glycerol.) The favorable effects of cocoanut oil are not due to more complete utilization of this fat, for stool analyses showed equally good utilization of the lard and cottonseed oil. Single fatty acids were prepared from cocoanut oil. Commercial stearic and oleic acids were purified by distillation. Synthetic homogeneous "fats" were made as mixtures of di- and tri-glycerides in each case of a single fatty acid. Animals deprived of vitamin B were not appreciably helped by the inclusion of 25 per cent. of the glycerides of stearic, of palmitic or of oleic acid, but considerably more by those of lauric or of capric acid. On the other hand the glycerides of myristic and capryllic acid were surprisingly efficacious. It is possible to look upon the favorable effect of cocoanut oil as due to its content in these two fatty acids. As was the case with natural fats so also with the glycerides of single fatty acids, it is impossible to ascribe the favorable effects of certain glycerides to their more complete utilization by the body; oleic, lauric and capric glycerides are far less efficacious, but are just as well utilized as are those of myristic and capryllic acids. We are not at present able to assign a particular physical or chemical characteristic of fats as the cause of this obscure new physiologic rôle in connection with water-soluble antineuritic B. It is further striking that while the separate glycerides of both stearic and of oleic acid have little efficacy, a mixture of these glycerides (four parts stearic with six parts oleic) is markedly beneficial to animals deprived of B. The facts presented would appear to force us to recognize new nutritive peculiarities in fats, quite apart from their caloric values or their content in the fat soluble vitamins at present known to science.

The importance of circulatory balance in the survival of replanted limbs: FREDERICK LEET REICHERT (introduced by Herbert M. Evans). Experience with wounds in the World War has definitely indicated that in arterial ligation the incidence of gangrene may be di-

minished by the simultaneous occlusion of the accompanying vein. By means of the experimental replantation of limbs the effect of simultaneous ligation of the main artery and vein to an extremity as compared with the effect of ligation of the artery or vein alone has been established chronologically. Gangrene does not develop if the main vein is ligated five or more days after replantation whereas the artery alone can not be safely occluded until the fourteenth day. The time interval essential to a safe arterial ligation can be diminished to seven days when a simultaneous ligation of artery and vein is performed. It is significant that the survival of the extremity after arterial ligation depends on the lapse of only a few hours before occlusion of the accompanying vein.

Bound water and free water in cells: L. B. BECKING (introduced by H. M. Evans). The experiments of de Vries which substantiated Van't Hoff's analogue on gas theory were performed with cells in which the swelling capacity of the protoplasm was insignificant. Osmotic laws fail to apply when the amount of hydrophilic colloid in cells is large. In the case of organisms living in concentrated salt solutions the amount of "bound" water is so great that osmotic laws no longer apply. Living cells, in general, display both osmotic and swelling activity. An interpretation of the processes of water absorption in terms of vapor pressure has been attempted on the basis of Katz's and Polanyi's deductions on swelling pressure and vapor tension of hydrophilic colloids.

The relation of bile to the intestinal absorption of vitamin A in the rat: CARL L. A. SCHMIDT and WERNER SCHMIDT (introduced by T. Wayland Vaughan). Experiments were carried out on rats which had been maintained on a low level of vitamin A to determine whether this vitamin is absorbed from the gastro-intestinal tract when bile is excluded by ligating and sectioning the common bile duct. The vaginal smear picture was used as a criterion to determine the absorption of the vitamin. It was found that icterus does not lead to the continuous appearance of cornified cells in the vaginal smears of animals which had been maintained on a diet adequate in vitamin A. When the abdomens of animals which had been maintained on a diet low in vitamin A were opened and closed surgically without, however, inducing icterus, subsequent administration of cod-liver oil restored the vaginal smear picture to normal. When icterus was induced in animals which had been maintained on a diet low in vitamin A by ligating and sectioning the common bile duct, the subsequent administration of cod-liver oil *per os* led to the reappearance of the normal vaginal smear picture in a certain percentage of the animals. This is interpreted as indicating absorption of vitamin A from the gastro-intestinal tract in the absence of bile. Both the mortality and the percentage of icteric rats which failed to respond to cod-liver oil when administered subcutaneously or *per os* are high. In several experimental icteric rats it was possible to restore the normal vaginal smear pictures by administration of cod-liver oil *per os,* then again to deplete the storage of vitamin A to such a level that only cornified cells were formed in the vaginal smears and a second time to restore the normal vaginal smear pictures by giving cod-liver oil *per os.*

The origin of limestone caverns: W. M. DAVIS. It is proposed, by extending the theory advocated by the German geographer, Grund, to explain the excavation of limestone caverns and the prevalent network pattern of their passages by the solvent action of ground water below the water table; and then to account for their more or less complete replenishment with dripstones by evaporation of percolating vadose water after regional elevation or other adequate cause has compelled the withdrawal of the ground water and its replacement by ground air.

Biotic cementation in coral reefs: WILLIAM ALBERT SETCHELL. Charles Darwin formulated a hypothesis to account for the origin and development of coral reefs. His fundamental arguments relied upon three sets of subsidiary hypotheses, *viz.:* I. Depth limitation of reef-forming corals; II. interconvertibility, *i.e.,* fringing into barrier, and barrier into atoll forms; with the resultant hypothesis, III, subsidence of the supporting platforms. Hypothesis I, founded on observation, is incomplete, since it overlooks the important rôle of cementing organisms, particularly that of the nullipores. Darwin and most later observers have assumed, but largely without supporting data, cementation, but largely inorganic in nature. At present the tendency is to include under coral reefs any calcareous reef structures whose components are largely corals, and to such an extreme has this view been carried that non-cemented structures have been included; *e.g.,* reefs, or more properly perhaps reef-like structures of coral rubble have been described in all seriousness as coral reefs, supposedly in the sense of Darwin, Dana, Agassiz, etc., in which reef growth has nothing of symbiotic cooperation to bring about the zonation so fundamental in the discussion of Darwin's hypothesis. Such extension of the term, without proper limitation, confuses the issue beyond measure and associates those marvelous structures where the cementation is biotic and whose controlling forces are living organisms with inchoate masses thrown into certain form and held to that form by nonliving, purely physical forces. Such calcareous reefs can not have growth in any biological sense, nor can they throw light on the origin and development of reefs in the Darwin-Dana sense.

The fossil flora of Goshen, Oregon, and its bearing on the problems of climatic change: RALPH W. CHANEY (introduced by David White). The Goshen flora of west central Oregon is made up of species many of which have generic equivalents in the subtropical forests of Central America; to a lesser extent the modern forests of central and southern China and of the Philippines contain elements corresponding to those of the fossil flora. It may be concluded that the physical conditions in western Oregon during the Eocene approached those on the Pacific slope of Central America to-day, with a rainfall of about 70 inches and a relatively high temperature. The Goshen flora represents the first unified fossil assemblage of a

subtropical type which has been studied on the Pacific Coast, where all the later Tertiary floras are typically temperate. It has much in common with the Eocene floras described from the Gulf states, but differs from them in much the same way that the modern forests of the Pacific slope differ from those of the Atlantic slope in Panama. Containing several genera to-day common to the neo-tropical and paleo-tropical forests, the Goshen flora may represent a record of the northward extension of a forest which had its origin in high latitudes at a time when there was a greater degree of climatic uniformity than now obtains, and whose survivors are found to-day only in the lower latitudes of both hemispheres.

Living micro-organisms in ancient rocks: C. B. LIPMAN (introduced by A. C. Lawson). Starting three years ago in a search for living micro-organisms in pre-Cambrian rocks I have continued the work and, on account of the sparseness of the flora in the pre-Cambrian rocks, decided to study anthracite coal inasmuch as it promised a richer flora. Many experiments have been carried out which leave no room for doubt of the existence of a bacterial population probably in some spore or resting stage inside of anthracite coal deriving both from Pennsylvania and from Wales. The final question as to whether these micro-organisms have found entrance into the inside of the anthracite coal measures in recent time or have been locked up in the coal measures from the time of their formation is under investigation.

The spherant, an instrument for observing hour angle or latitude directly: HOWARD B. KASTER. The instrument described in this paper and exhibited at the meeting has been under development at the University of California for several years. It breaks the old tradition that a navigator, in order to find his position, must measure an altitude and then solve a spherical triangle. The instrument gives directly either hour angle or latitude. The observed hour angle, combined with the proper Greenwich hour angle from a watch or chronometer, yields the longitude. Usually such latitudes and longitudes are not independent but lie along a Sumner line, as in the case of reduced sextant observations. The advantage lies in the elimination of practically all computation or use of tables. The instrument has the same weight as the average sextant, and *with the same amount of practice* is as easily handled. It is called a spherant.

A radio system for blind landing of aircraft in fog: H. DIAMOND and F. W. DUNMORE (introduced by George K. Burgess). This system includes three elements in order to indicate the position of the aircraft in three dimensions as it approaches and reaches the point of landing. (1) *Lateral position*—Such position given for the purpose of keeping the airplane directed to and over the runway is indicated by two vibrating reeds on the pilot's instrument board, the driving electromagnets of which are connected to the output of the airplane's radio receiver. These reeds, one of which is mechanically tuned to 65 cycles and the other to 86.7 cycles, are actuated by a radio signal sent from two coil antennas crossed at 90°, the signal from one coil antenna being modulated at 65 cycles and that from the other at 86.7 cycles. On the course (*i.e.*, along the line bisecting the angle between the two antennas) the reed vibration amplitudes are equal. Off the course they are unequal, the reed vibrating with the greater amplitude being on the side to which the airplane has deviated. An automatic volume control feature is used to keep the reed amplitudes within bounds as the field is approached. (2) *Vertical guidance*—A high frequency (100 megacycles, 3 meters) beam directed over the runway at an angle of 8° above the horizontal and located at the further end of the landing field is used for such guidance. On the airplane, the signal current in the output circuit of the special high-frequency receiving set employed is rectified and passed through a d.c. microammeter mounted on the instrument board. The airplane does not fly on the axis of the beam, but on a curved path under the beam whose curvature diminishes as the ground is approached. The path is the line of equal intensity of received signal below the axis of the beam. The diminution of intensity as the airplane drops below the beam axis is compensated by the increase of intensity due to approaching the beam transmitter. Thus, by flying the airplane along such a path as to keep the deflection of the microammeter on the instrument board constant, the pilot comes down to ground on a curved line suitable for landing. No manipulations on the part of the pilot are required. The tuning is fixed. Since a line of constant field intensity is followed no control of volume is necessary. (3) *Longitudinal guidance*—A field boundary marker beacon is used for this purpose. It operates on the same carrier frequency as the runway localizing beacon and both beacons are received simultaneously on the medium-frequency receiving set. A modulation frequency of 1,000 cycles is used. A coil antenna oriented to give a minimum signal zone along the border of the field is used, the minimum signal indicating to the pilot that he is over the edge of the field.

Some aspects of Martian meteorology suggested by the behavior of Martian mists and clouds: W. H. WRIGHT.

The principle of identity: G. N. LEWIS.

On the production of high speed protons: ERNEST O. LAWRENCE and N. E. EDLEFSEN (introduced by G. N. Lewis). Very little is known about nuclear properties of atoms because of the difficulties inherent in excitation of nuclear transitions in the laboratory. The study of the nucleus would be greatly facilitated by the development of a source of high speed protons having kinetic energies of about one million volt-electrons. The straightforward method of accelerating protons through the requisite difference of potential presents great difficulties associated with the high electric fields necessarily involved. Apart from obvious difficulties in obtaining such high potentials with proper insulation, there is the problem of development of a vacuum tube suitable for such voltages. A method for the acceleration of protons to high speeds which does not involve these difficulties is as follows. Semicircular hollow plates in a vacuum not unlike duants of an electrometer are placed in a

uniform magnetic field which is normal to the plane of the plates. The diametral edges of the plates are crossed by a grid of wires so that inside each pair of plates there is an electric field free region. The two pairs of plates are joined to an inductance thereby serving as the condenser of a high frequency oscillatory circuit. Impressed oscillations then produce an alternating electric field in the space between the grids of the two pairs of plates which is perpendicular to the magnetic field. Thus during one half cycle the electric field accelerates protons into the region between one of the pairs of plates where they are bent around on a circular path by the magnetic field and eventually emerge again into the region between the grids. If now the time required for the passage along the semi-circular path inside the plates equals the half period of the oscillations, the protons will enter the region between the grids when the field has reversed direction and thereby will receive an additional acceleration. Passing into the interior of the other pair of plates the protons continue on a circular path of larger radius coming out between the grids where again the field has reversed and the protons are accelerated into the region of the first pair of plates, etc. Because the radii of the circular paths are proportional to the velocities of the protons the time required for traversal of a semicircular path is independent of the radius of the circle. Therefore once the protons are in synchronism with the oscillating field they continue indefinitely to be accelerated on passing through the region between the grids, and spiraling around on ever-widening circles gain more and more kinetic energy from the oscillating field. For example, oscillations of 10,000 volts and 20 meters wave-length impressed on plates of 10 cm radius in a magnetic field of 15,000 Gauss will yield protons having about one million volt-electrons of kinetic energy. The method is being developed in this laboratory, and preliminary experiments indicate that there are probably no serious difficulties in the way of obtaining protons having high enough speeds to be useful for studies of atomic nuclei.

The effects of rediffusion of cathode rays upon X-ray structure: D. L. WEBSTER, H. CLARK and W. W. HANSEN, Stanford University. An extremely thin target, for an X-ray tube for spectral line intensity measurements, may be made by depositing the metal to be investigated on a block of beryllium. The intensities of the lines must then be corrected by subtracting the intensities due to such cathode rays as are "rediffused" from the beryllium, thus penetrating the target a second time. This correction was tentatively estimated, in a preliminary report[1] on such measurements, for silver, as "a few per cent." But Wisshak,[2] in discussing his recent measurements of X-rays from thick targets, disagrees with our results by much greater percentages, and concludes that the difference must be attributed to rediffusion. This makes it desirable to calculate the effect of rediffusion more exactly. The question becomes especially important because of Bethe's[3] new theory of ionization by electron impact. If Wisshak's data and his corrections to them are accurate, Bethe's theory must be quite inapplicable to the inner electrons. On the other hand, its deviations from our data are only of the order of 10%. So if our data are accurate and our corrections are small, it is at least a reasonable approximation. To calculate these corrections, we need first the rediffusion constant for beryllium. From Schonland's[4] measurements on other metals, and Wentzel's[5] theory, we estimate this as 0.044. We assume the rediffusion velocity spectrum to be of a general type found by Wagner;[6] but to insure against the uncertainty in the translation of his photographic densities into numbers of electrons, calculations are made for a great variety of values of the mean energy of rediffusion. It is found that for all voltages up to 3 times the excitation voltage V_K, the results are but little affected by any reasonable changes in this quantity. Taking the intensity at 2 V_K as a standard by which to fix the arbitrary intensity unit, the correction at voltages up to 3 V_K never exceeds 3 or 4½ per cent.; furthermore, it is partially cancelled, by a correction for the lengthening of the paths within the silver by diffusion there. The comparison with Bethe's theory, made above, is therefore practically unaffected. For thick targets, rediffusion makes the intensity at any frequency increase less rapidly with voltage than it would without rediffusion; so the corrections are of opposite sign from those for thin targets. For silver, expressed as percentages of the intensity, they are about 2 to 4 times as great. On continuous spectra, these calculations practically verify Kramers' suggestion, that the non-linear term in the continuous intensity function is due to rediffusion; but there is a residue, probably due to the diffusion occurring before rediffusion. For when the cathode rays first lose their parallelism, they lose their ability to emit polarized X-rays. This initial diffusion therefore affects the intensities observed in any given direction, and it probably accounts, in part at least, for the dependence of the non-linear intensity term on the direction.

Phase rule equilibria of horse serum globulin: ELOISE JAMESON and J. W. MCBAIN (introduced by W. C. Bray). Although proteins are of great biological importance, still no consistent account of the equilibria into which they enter can be obtained from existing scientific literature. Taking advantage of the recent developments in the isolation of unaltered proteins as tested by the experiments of Svedberg with the ultra centrifuge, a specimen of horse serum globulin was prepared by his method. Observations were made of the various physical states it could assume and the conditions under which these forms and their solutions may exist. The composition as regards amounts of protein, water, salt and acid of the material in these states, as well as some other properties, have been determined. The study of the equilibria between the

[1] D. L. Webster, H. Clark, R. M. Yeatman and W. W. Hansen, *Proc.* Nat. Acad. Sci., *14,* 679, 1928.
[2] F. Wisshak, *Ann. der Phys., 5,* 507, 1930.
[3] H. Bethe, *ibid., 5,* 325, 1930.
[4] B. F. J. Schonland, *Proc.* Roy. Soc., A *108,* 187, 1925.
[5] G. Wentzel, *Ann. der Phys., 70,* 561, 1923.
[6] P. B. Wagner, *Phys. Rev., 35,* 98, 1930.

various forms of globulin and its solutions was carried out by analysis of the two phases appearing upon evaporation of a globulin solution, or upon addition of ammonium sulphate to the solution, or upon dialysis of the same. A remarkable similarity to soap was observed, both between the forms of globulin and soap separating and the shapes of the areas representing the solutions of the two substances. After dilution or concentration of globulin solutions and precipitation with ammonium sulphate, points representing analyses of the liquid phase fall on the curve found with the original solution, or in a special case coincide with a point previously found. Lines passing through these points and those representing the mixture from which the phases separate indicate that these phases are the same as those separating from the stock solution. Thus the equilibria were found to be reproducible and the applicability of the phase rule established. In the case of the globulin form which separates on dialysis, resolution and precipitation gave points falling below the curve mentioned above. This we suggested was probably due to aggregation of the particles brought about, perhaps, by surface denaturation of the protein during dialysis. It appears that globulin solutions, euglobulin and pseudoglobulin are but three phases of a system of the same mother substance, dehydrated globulin, solutions of globulin being the ordinary isotropic solutions, while euglobulin and pseudoglobulin are liquid crystalline phases or a liquid and glass which are slightly doubly refracting.

The heat of formation of water:[1] FREDERICK D. ROSSINI (introduced by George K. Burgess). The usually accepted value for the heat of formation of water is based upon measurements made by Thomsen in 1873, Schuller and Wartha in 1877 and Mixter in 1903. The most accurate and precise of these data are those of Schuller and Wartha, whose average value has an uncertainty of nearly 0.1 per cent., practically all of which lies in the calibration factor of their calorimeter. The procedure employed in the present investigation was to determine directly the quantitative correspondence between (1) the energy liberated when hydrogen and oxygen combine to form a weighed mass of H_2O and (2) a measured quantity of electrical energy, by using the calorimeter as the absorber of the two energy quantities and its temperature rise as the comparator. In so far as systematic errors are concerned, the absolute accuracy depends only upon the determination of the mass of water formed, in grams, and of the quantity of electrical energy, in terms of the mean solar second and the international volt and international ohm. High precision is obtained by the use of proper calorimetric technique, a sensitive device for measuring changes of temperature, a sensitive potentiometric system for measuring the electrical power input, a precision timing device and a suitable balance for weighing the H_2O formed. The data of two sets of nine experiments each give 285,775 international joules per mole (18.0156 g) for the heat of formation of liquid H_2O at 25° C., 1 atm. With the factors 1.0004 and (1.0004/4.185), this is equivalent to 285,890 absolute joules or 68,313 g-cal_{15}. The maximum and the average deviations, in percentages, are, respectively: 0.031 and 0.019 in Set I; 0.024 and 0.010 in Set II. The data of Schuller and Wartha, Thomsen and Mixter were recomputed in terms of the international joule. Their average values plus or minus the assigned errors are entirely concordant with the value obtained in this investigation.

[1] Published by permission of the director of the Bureau of Standards, Department of Commerce, Washington, D. C.

Diffusion of electrolytes and of colloids in aqueous solution: T. H. LIU and J. W. MCBAIN (introduced by W. C. Bray). By standardizing the procedure in the Northrop method of confining the diffusion gradient within a coarsely porous diaphragm, diffusion coefficients are easily obtainable which are reproducible within a fraction of a per cent. They agree well with the few good results which the laborious classical methods have hitherto produced but they permit of far closer scrutiny as to the effects of such factors as concentration. Substances in mixtures do not diffuse independently but may accelerate, retard or even reverse the diffusion of another and an action may be set up resembling that in a gaseous diffusion pump. Diffusion data point to incomplete dissociation of electrolytes, and the Nernst equation for a diffusion at infinite dilution is extended to cover high concentrations of potassium chloride. Other applications are to cadmium iodide with its complex ions and to constituents of soap solutions as colloidal electrolytes.

(To be continued)

BOOKS RECEIVED

Contributions from the Biological Laboratory of the Science Society of China: Study of the Fishes of Amoy, by Hsien Wen Wu. Pp. 90. 70 figures. Prodromus Florae Sinensis, by H. H. Hu. Pp. 77. The Science Society of China, Nanking.

CRONEIS, CAREY. *Geology of the Arkansas Paleozoic Area, with Especial Reference to Oil and Gas Possibilities.* Pp. xx + 457. Illustrated. Arkansas Geological Survey.

GUDGER, EUGENE W. *The Candirú, the only Vertebrate Parasite of Man.* Pp. xvii + 120. 18 illustrations. Hoeber. $1.50.

GUYÉNOT, ÉMILE. *La Variation et l'Evolution.* Pp. 414. Gaston, Doin & Cie. 32 fr.

LUQUET, G. H. *L'Art Primitif.* Pp. x + 265. 141 figures. Gaston, Doin & Cie, Paris.

MANN, CLAIR V. *Objective Type Tests in Engineering Education.* Pp. x + 122. Illustrated. McGraw-Hill. $2.75.

OLIVER, WADE W. *Stalkers of Pestilence:* The Story of Man's Ideas of Infection. Pp. xix + 251. Illustrated. Hoeber. $3.00.

PARSONS, ROBERT P. *History of Haitian Medicine.* Pp. xxviii + 196. 21 illustrations. Hoeber. $2.25.

RIGG, GEORGE B. *College Botany.* Pp. xviii + 442. 157 illustrations. Lea & Febiger. $4.00.

SMALLWOOD, WILLIAM M. *A Text-book of Biology:* For Students in General, Medical and Technical Courses. Sixth edition, revised. Pp. xvi + 470. 178 illustrations. Lea & Febiger. $4.00.

TAYLOR, T. CLINTON. *Reactions and Symbols of Carbon Compounds.* Pp. x + 704. Century. $4.00.

WOOD, A. B. *A Text-book of Sound.* Pp. xiv + 519. 156 figures. Macmillan. $6.50.