cell, while the larger portion of the tube (C) becomes the reservoir for the fluid to be introduced into the cell. The smaller portion of the tube is placed in the trough in the slide with the reservoir in a vertical position, and sealed in place by means of De Khotinsky cement or sealing wax. For an outlet to the observation cell, a small glass tube (D) is drawn to approximately 0.5 mm and the opposite end bent to form an inverted U. This tube is placed in the other trough and similarly fastened in place, while the inverted U at the end prevents the liquid from running back along the tube. A cover glass (E, E′) is sealed over the ends of the troughs in such a way as to enclose the ends of both tubes. The side of the cover glass (E′) over the inlet and outlet tubes will be held a small distance above the surface, which will result in a small slant in the cover glass, giving a varying depth to the observation cell.

The material to be studied is introduced into the reservoir, where it drains into the observation cell. With the outlet closed by the finger, air pressure is exerted against the contents of the reservoir (C) with the result that the cover glass is slightly sprung, and the solid objects are forced between the cover glass and the slide where they become trapped with the release of the pressure and the return of the cover glass. Because of the varying depth of the cell it is now possible to select an individual object so located as to be firmly held by the cover glass, but not crushed or distorted. By adding any liquid to the reservoir, a constant bath of the desired liquid can be maintained around the object, while the object remains in focus in a photomicrographic camera or under a microscope. No difficulty has been encountered in maintaining coccidia in focus under either a No. 6 Leitz dry or a 1-7 oil immersion objective.

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A SIMPLE DEVICE FOR HOLDING ULTRAFILTRATION MEMBRANES

THE use of filtration through collodion membranes as a means of purifying biological products and determining the size of colloidal particles is becoming more wide-spread. Many apparatuses have been described to hold the membranes but their construction requires special glass blowing or machine work. The device described here can be prepared in any laboratory.

The filter membrane is held between two glass funnels and is protected from their ground edges by a rubber washer above, and a rubber band stretched over a metal washer below the membrane (Figure 1).

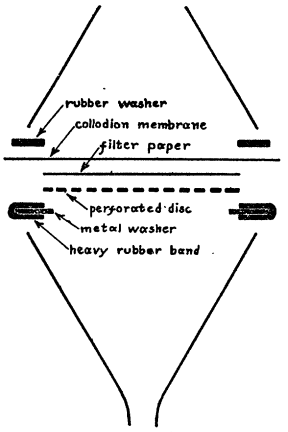

FIG. 1

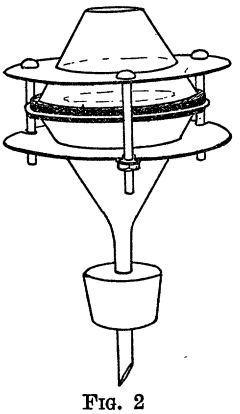

FIG. 2

The metal washer supports a perforated disc upon which is placed ordinary filter paper of the same diameter. When assembled, the top of the rubber band and of the filter paper are in the same plane, to prevent distortion of the membrane under pressure. The filter paper between the collodion membrane and perforated disc serves to increase the effective filtration area.

The funnels are clamped together by two rings of metal or Bakelite as shown in Figure 2. If the filter is to be autoclaved metal rings are advisable. In using metal rings, holes are drilled around their inner edges and a narrow strip of rubber woven through the holes and around the inner edge of the ring, forming a cushion between the funnels and rings.

When autoclaving, the membrane is replaced by filter paper and the apparatus is clamped loosely. After sterilization, the filter paper is replaced by the collodion membrane.

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The oxygen carriers of the blood in their relation to sex and season: OSCAR RIDDLE. For only two or three species of animals has it been definitely known that hemoglobin and red cells exist in different quantity in the blood of the two sexes, and seasonal changes in these values are very little known. Data of Riddle and Braucher make it clear that in two additional species—ring dove and pigeon—this sex difference is present, that here also these oxygen carriers exist in larger amount in male blood, and that hemoglobin and red-cell values markedly change with season. Riddle, Christman and Benedict have measured the basal metabolism of these

same animals and find that the metabolism also undergoes marked seasonal change. In two species it is thus found that the metabolism, the hemoglobin and the red cells are all decreased to their lowest point in summer and all attain their highest values in the autumn—the season at which these animals were subjected to air of greatest cooling power. All these changes occur in individuals of both sexes. The implantation of male germ glands (testes) into castrated female birds and mammals is known to produce an increase in the hemoglobin or the cell count, or both, in the blood of the castrate; and it has been claimed that this demonstrates that hemoglobin and erythrocytes are secondary sex characters. The new data prove that this conclusion is unsound. The secondary sex characters of birds and mammals represent specific responses of developing parts, areas or tissues to a specific sex hormone; they do not respond to changes in basal heat production as such. Hemoglobin and erythrocytes, however, do undergo their major fluctuations—both increase and reduction—in close correspondence with the seasonal changes in metabolism. The oxygen carriers of the blood fluctuate with the oxygen demands of the tissues, and their sex difference reflects unequal oxygen demands of male and female tissues. These oxygen carriers therefore appear to reflect primary sex difference and to contribute further evidence for the metabolic theory of sex.

The present status of wire-wireless broadcasting on power lines: GEORGE O. SQUIER. As a research student in physics and electrical engineering under Rowland and Duncan in "the golden age" of the Johns Hopkins University over forty years ago, I well remember the discussions which then took place as to the relative merits of direct and alternating current for power transmission. When the alternating current system began to appear the major decision to be made was to select the frequency. Little did the small group which formed a part of the "Big Eight" realize that when the number 60 cycles per second was selected after wide discussion throughout the small engineering profession in the United States at that time, at a single stroke a step was taken which has determined the design of the whole vast power-wire pattern which to-day links this country from ocean to ocean, and from the Great Lakes to the Gulf of Mexico. To-day this aristocratic number 60 throbs incessantly throughout a vast territory extending from the remote farmer's cottage to the heights of the Empire State Building in New York City. This national pendulum ticks with a regularity and accuracy which permit us to live in a split-second world which it has created. There was another key decision made at that time whose history is not so easy to determine. Some unknown mechanic or electrician casually decided to construct the standard lamp socket of the diameter of one inch, and to employ the basic principle of the screw for reliable electrical contact. To-day the number of these standard sockets in use in the United States is roughly estimated as $50 \cdot 10^7$. On September 18, 1910, for the first time, two separate telephone conversations were carried on over a single "twisted pair" wire telephone circuit between the Signal Corps Laboratory at the National Bureau of Standards in Washington, D. C., and the small laboratory at 1710 Pennsylvania Avenue. Then was born the new art of wire-wireless communication engineering. At the annual meeting of this academy in April of the present year, I brought to the attention of the academy a new development of wire-wireless called the monophone, or one-way telephone, for broadcasting and pointed out at that meeting the astonishing fact that our telephone plant, which has now reached 80 million miles of wire, was operating only about 18 minutes a day or at an "overall inefficiency" of some 98 per cent. The magazines recently announced that these idle wire facilities are being reserved for a two-way long distance television service as supplementary to the point-to-point service on the regular telephone plant. At 4 p. m. on March 24, 1922, in the presence of the Associated Press and a group of radio engineers, occurred the first demonstration of wire-wireless broadcasting of programs on the regular standard electric light circuit in the office of the chief signal officer of the army, in the Munitions Building, across the street from the National Academy of Sciences Building in Washington. To-day after nine years I have to report a practical development extending continuously throughout this period at a cost of some three millions of dollars where at present a staff of 75 men are employed in the laboratory at Ampere, New Jersey. Superimposed upon the 60 cycle power transmission plant without interference, is a 13 kilocycle carrier current which is stepped up in multiples of the lucky number 13 to deliver three separate programs simultaneously into the homes of subscribers from the standard light socket on frequencies of 26, 39 and 52 kilocycles per second. The complete equipment designed, manufactured and tested for 270,000 homes is now ready for shipment to Cleveland, Ohio.

A critical study of the magneto-optic method of analysis: JACOB PAPISH and A. C. SHUMAN (introduced by W. D. Bancroft). The magneto-optic method of analysis was applied to the identification of a number of chemical elements. The method was found inadequate in the case of mixtures, and the authors call attention to the fact that further study may throw light on the cause of "minima" observed when solutions are examined by this method.

The Zeeman effect in the $^2\Sigma$, $^2\Sigma$ *band spectrum of calcium hydride:* WILLIAM W. WATSON (introduced by F. Schlesinger). This paper deals with the effect of a magnetic field on the energy levels of the type known as $^2\Sigma$ for diatomic molecules, with the object of learning more about the dynamics of such molecular states. The $^2\Sigma$, $^2\Sigma$ band spectrum of calcium hydride in the region of 6350A serves the best for this investigation because of the record size of the doubling of the energy levels involved, the wide spacing of its lines and its position in the spectrum. The spectrum has been photographed at various strengths of the magnetic field up to 30,000 gauss, and the resulting measurements compared with the patterns of the spectral lines as pre-

dicted by existing ideas of the dynamical behavior of molecules in $^2\Sigma$ states. The results show that the magnetic interaction is largely that of an electron spin of $\frac{1}{2}$ a Bohr unit and the external field, superposed on the internal coupling of electron spin to the rotational axis of the molecule. Marked asymmetries in the patterns appear for lines arising from the higher rotational levels of the molecule, however, which can be attributed to the presence of a sizable component of electronic orbital angular momentum along the axis of rotation. Data on the relative intensities of the different kinds of energy transitions in the presence of the magnetic field are also presented.

Imaginary geometry and relativity: EDWARD KASNER.

Applications of relativistic thermodynamics to cosmological problems: RICHARD C. TOLMAN. For several years the author has been endeavoring to develop the principles for an extension of thermodynamics to general relativity, which would make it possible to treat the thermodynamic behavior of systems under circumstances where the gravitational field can not be neglected. The purpose of the present paper is to give a brief summary of the results that have been obtained by applying the new principles to several problems which might be of interest for cosmology. Some of these results have previously been published. The principles were first applied to systems in static thermodynamic equilibrium. In the case of a non-uniform static gravitational field, it was shown that the conditions for thermal equilibrium would necessitate a definite temperature gradient in order to prevent the flow of heat from regions of higher to those of lower gravitational potential. And, both in the gravitational field of a spherical distribution of fluid and in that of a static Einstein universe, it was shown that the concentration of matter in equilibrium with radiation, assuming their interconvertibility, would be the same as in flat space-time. The principles were then applied to non-static systems in which reversible processes take place. Possibilities were found which do not exist in the classical thermodynamics for processes to take place at a finite rate and nevertheless reversibly without increase in entropy. It was shown that several different models of the universe could expand or contract at a finite rate and yet reversibly without increase in entropy; and a number of phenomena were found in the case of reversibly expanding universes, such as the outward flow of radiation, which have ordinarily been interpreted as irreversible. The possibilities for periodic expansion and contraction of the models was also studied, and it was shown that although no strictly periodic solutions of the equations of motion are possible, nevertheless, quasi-periodic motions are allowable which would in effect give a series of identical expansions and contractions without increase in entropy. Finally, the new principles have been applied to non-static systems in which irreversible processes take place. Owing to the well-known fact that the principle of the conservation of energy does not hold in relativistic mechanics in the same simple form as in classical mechanics, it is found that the possible increases in entropy which accompany the occurrence of irreversible processes in an isolated system are not subject to a limitation such as imposed in the classical thermodynamics by a fixed constant value for the energy of the system. Indeed, models of the universe can be conceived which would undergo a succession of irreversible expansions and contractions without the entropy reaching an unsurpassable maximum where further change would be impossible.

The equation of state of real gases and its quantum dynamical correction: HENRY MARGENAU (introduced by F. Schlesinger). The equation of state of a gas is a mathematical expression of the manner in which the pressure changes when temperature and volume are varied. Its usual derivation is based upon the picture according to which each molecule may move freely in space and attracts every other molecule with a force depending on the distance of separation. There is no restriction upon the velocity which any given molecule may possess. By quantum dynamics it can be shown that, under the action of attractive forces of the actually existing type, pairs of molecules may, under certain conditions, form a loose combination, different from a chemical bond. When two structures are bound together in this way they vibrate in a definite manner with roughly calculable frequencies, which make it impossible for the individuals to have any velocity whatever. Hence, in the calculation of the equation of state, these impossible velocities must be excluded. In the present paper this calculation is carried through. The result does not differ appreciably from the usual one if the gas is considered at high temperatures, but at low temperatures a considerable difference arises. While it is difficult at present to make accurate numerical comparisons between the theoretical formula and empirical observations, the corrections which this theory imposes are qualitatively in line with the available experimental evidence.

A new photographic map of the Moon: F. E. WRIGHT and F. G. PEASE. In selenographic literature the question of possible changes in the surface features of the Moon is under constant discussion and the answer is sought in a comparison of early, with more recent, maps and descriptions. No satisfactory decision has been reached because all maps heretofore produced have been drawn by hand and these are subject to personal factors difficult to evaluate. The present series of maps seeks to eliminate the personal factor and to produce, with the best means at present available, a series of photographic maps in which the photographs taken with the 100-inch Hooker telescope at Mt. Wilson Observatory are transformed by a special method of projection, so that in each photograph the Moon is viewed along the standard line of sight normal to the plane of mean libration. The principle of transformation is similar to that used in airplane mapping; but the method adopted is quite different because the whole

lunar hemisphere is involved and not simply the transformation from one plane surface to another.

Metabolic activity of the bacterial cell: C.-E. A. WINSLOW and HAROLD H. WALKER (introduced by G. P. Clinton). Bacteria of the colon group have been cultivated in vessels continuously aerated during the course of the experiment with air which had been freed from carbon dioxide and ammonia. The effect of the aeration procedure on growth was determined and average curves plotted for the population cycle. Specific growth phases of short duration were selected at various points on the population cycle and simultaneous determinations made, at the beginning and end of each phase, of bacterial increase, reaction change in the medium, sugar consumption, change in CO_2 and NH_3 content of the medium and aeratable CO_2 and NH_3 collected by the air train during such period. This method of cultivating bacteria in a continuously aerated medium gives a more normal picture of the life cycle of a bacterial population than that obtained in ordinary techniques which involve the rapid inhibition of the organisms by their own waste products. Three basic media were used, 1 per cent. peptone solution, a solution containing ½ per cent. peptone and ½ per cent. lactose and a simple synthetic medium (the Dolloff medium) containing ammonium tartrate as a source of nitrogen and lactose as a source of energy. There is a definite life cycle for each medium, involving (a) a preliminary lag with little change in population, (b) a logarithmic increase in numbers and (c) a period of relative stability. The process of aeration, it is interesting to note, is highly favorable to development in the lactose and peptone media through the removal of toxic waste products, but is distinctly inhibitory in the simple synthetic medium, presumably through the removal of growth-stimulating substances. The principal results to date appear to be the demonstration that the production of both carbon dioxide and ammonia-nitrogen per cell increases enormously during the period of active multiplication or logarithmic increase. Late in the preliminary lag period and in the phase of logarithmic increase the culture produced $40–100 \times 10^{-11}$ milligrams of CO_2 per cell per hour, while in the later period of stability the figure fell to $1–2 \times 10^{-11}$. For ammonia-nitrogen, the rate of production during the late lag phase was about 15×10^{-11} mgm per cell per hour and for the phase of logarithmic increase, 4×10^{-11} while for the phase of ultimate stability ammonia production fell to 0.2×10^{-11}. During the lag phase the ratio of carbon dioxide to ammonia-nitrogen is about 4, during the logarithmic phase over 10 and during the period of stability when growth balances death about 6, expressed in relative weights of the gases yielded. If we compare the metabolism of the cells during the period of lag and of logarithmic increase with their metabolism during stability of population we find that CO_2 production is increased thirty-fold and $NH_{3\text{-}N}$ production 20–70 fold. The ammonia formed may of course be largely derived from extracellular decomposition of pepton. The increase of CO_2 production, however, would seem to be a measure of increased metabolism due to the physiological condition of the actively multiplying cells.

The physical and behavioral development of a female chimpanzee during the first year of life: C. F. JACOBSEN (introduced by R. M. Yerkes).

Some observations of the behavior of chimpanzees in a native habitat: H. W. NISSEN (introduced by R. M. Yerkes).

Reinforcement and inhibition of eyelid reflexes to light and sound: ERNEST R. HILGARD (introduced by R. Dodge). A faint stimulus, itself eliciting only minimal reflex responses, may greatly exaggerate or depress the responses to a more adequate stimulus which follows it. This is demonstrated in certain experiments on the human eyelid reflex, in which a faint light preceded a loud sound. The light alone evoked winking responses averaging 4 mm in extent, while the sound evoked winking responses averaging 20 mm. When the light preceded the sound by appropriate intervals (of from 0 to .050 sec.) the response to the sound was increased to a maximum average extent of 31 mm, an increase of 11 mm above the normal. This increase of 11 mm is due to the prior occurrence of a light which alone evoked a response of but 4 mm. On the other hand, the response to sound may be greatly decreased in extent if the light precedes the sound by a slightly lengthened time interval (interval of .075 sec. or greater). This inhibitory effect is even more pronounced than the reinforcement just described. The reaction to sound may fall as low as 1 mm in extent from the normal of 20 mm, a drop of 19 mm. All the eyelid responses were recorded by the photographic method of Dodge, using his pendulum photochronograph. The experiments point to the importance of the faint stimuli playing upon the organism and creating the dynamic background into which a new stimulus is received. The responses to the new stimulus will be greatly modified by immediately preceding events. The reversal of effect from reinforcement to inhibition with fine changes in time relations bears importantly on the theory of conditioned reflexes widely used by psychologists in explanation of habit formation.

Some psychopathological aspects of the personality of the scientist: DR. EUGEN KAHN (introduced by Dr. Raymond Dodge). Every personality is a complex combination of physical, impulse, temperament, instinct, intelligence and character factors. The individual combination of these factors is decisive for the personalities' attitudes. Evidently all these factors must be present, to some degree, in the scientific personality. It may be desirable to consider three special attitudes which seem to be outstanding in the personality of the scientist: Ambitendence, anancasm and paranoia.