also isolated in a pure state copper protein compounds from blood corpuscles and liver (hæmocuprein and hepatocuprein), which may be of biological importance though they are not apparently concerned in oxidase reactions. Keilin has thus provided us with an integrated picture of cellular respiration which is an enormous advance on the much less systematized knowledge that we had before his work was published.

DAVY MEDAL

The DAVY MEDAL has been awarded to Prof. JAMES WILLIAM MCBAIN.

McBain's claim to special recognition rests essentially on the circumstance that he created, and has led the development of, a new and important chapter of physical chemistry—the study of colloidal electrolytes. It was as the result of a long series of precision measurements on the electrical and thermodynamic properties of soap solutions that McBain originally defined this new class of materials, which combine in a special way the properties of colloids and electrolytes. The definition and constitutional theory proved to be the key to the orderly exploration, which thenceforth proceeded with continually growing impetus, of a large and fruitful field—incidentally one of considerable technical importance. The materials include soaps, nearly all modern synthetic detergents, a number of inorganic substances such as silicates and tellurates, as well as many dyes, proteins and bio-colloids.

In the continued investigation, in which numerous workers have contributed to the general development of the subject, McBain has been a leader, and his work has thrown much light not only on the special properties of the ionic micele, but also on the physical properties of colloidal particles as a whole. In the course of this work a great variety of experimental methods has been developed—chemical, electrical, optical and mechanical methods—which are novel in their application and are in some cases novel in themselves. Reference may be made to the quantitative study of 'solubilization' and the elaboration of the air-borne ultracentrifuge in illustration of McBain's versatility of technique.

In addition to the composition and organization of a colloidal particle, its interface with the continuum has a decisive influence on its properties, and this gives special importance to the section of McBain's work which deals with the structure, composition and depth of macroscopic interfaces, especially of the surfaces of colloidal electrolyte solutions. Here also he has devised many methods of study, one of the most striking being the 'microtome' method whereby the outermost layer of a solution can be peeled off with a rapidly moving knife blade so that the surface concentration of solute can be directly determined.

HUGHES MEDAL

The HUGHES MEDAL has been awarded to Prof. GEORGE PAGET THOMSON.

Thomson's researches have been spread over a wide range of experimental and theoretical physics. Most of his earlier experiments were connected in some way or another with positive rays, and in this field he obtained a number of valuable results. Probably the most important of these is his discovery that the small-angle scattering of protons in hydrogen could not be accounted for by treating the protons and electrons as point charges obeying the inverse square law of force.

The scope of his work in pure physics is indicated by the titles of three books he has written or, in one case, helped to write. These are: "The Atom", "Wave Mechanics of the Free Electron" and the third edition of "Conduction of Electricity through Gases". The last is a joint effort with his father, and is the most important work there is on the subject. Within this range his work is both experimental and theoretical, but the experimental part predominates both in quantity and in importance.

Thomson has also made notable contributions to aeronautics. They include research work for the fighting air services during the War of 1914–18, a book entitled "Applied Aeronautics" (1919), and various contributions to Government publications.

Thomson's most distinguished work is based on Davisson's discovery—finally established in 1927—that electrons were reflected by single crystals as if they were possessed of the characteristics of waves. By brilliant experiments and able reasonings thereon, Thomson has opened out a new field of research which has been singularly fruitful and is still full of promise. He has been able to prove by direct experiment the correctness of Louis de Broglie's ideas of wave mechanics, not merely qualitatively but also quantitatively.

THE GREAT RED SPOT ON JUPITER

THE presidential address of the British Astronomical Association was delivered on October 25 by Mr. B. M. Peek, who took for his subject the physical conditions of the planet Jupiter, and in particular the red spot. It is certain that Schwabe's drawings in 1831 showed this spot, and there is evidence that it was known from 1664, the date of Hooke's famous observation, until 1713, from which date a gap of more than a century exists in the records.

It is difficult to believe that a purely atmospheric phenomenon could have continued so long without showing signs of dissipation, but the anomalies of its motion in longitude militate against the view that it arises from a centre of activity more deeply rooted than the atmosphere. It rotates nearly in accordance with system ii, that is, the system which represents approximately the period of features commonly seen outside the equatorial zone, 9h. 55m. 40·632s. An attempt was made by Peek to determine what system of uniform rotation most nearly represents the rotation of the spot from 1891 until 1931, but it is admitted that a simple mathematical expression to represent the motion is difficult to find, and the investigator is obliged to ask the question whether, in spite of its long persistence, the red spot is not a purely atmospheric phenomenon. At this stage of

the inquiry it is necessary to define the term 'atmosphere'.

Both Wildt and Peek have shown that beyond a depth of 100 km. the atmosphere of Jupiter must be compressed to the density of the liquid or solid state of the substances composing it. It is possible to conceive of this atmosphere as composed of highly condensed permanent gases, and at greater depths these gases may be solidified. The temperature of the surface of such an atmosphere would probably be in the neighbourhood of 150° K. (— 123° C.), and from the dry adiabatic lapse-rate at the surface of Jupiter it is certain that the temperature must increase rapidly with the depth for the first few kilometres. When, however, the gas laws break down, it is probable that practically isothermal conditions prevail and the isotherm may be about 300° K. Jeffreys' investigations suggest that a thick layer composed of one of Bridgman's high-pressure modification of ice, probably ice vii, lies underneath, and Peek considers the case of an enormous berg, towering above the general level of the layer. Would the viscosity of the ice allow it to drift in longitude like the red spot ?

Mr. Peek then develops a suggestion made by Wildt[1] that the spot may be a solid body floating in an 'ocean of permanent gases', and proposes the following tentative hypothesis: A solid body *A*, which is provisionally called ice, floats in a permanent gas *B*, provisionally called nitrogen. If the former is ice vii, it may be supposed that a small portion near the top would gradually change its phase from ice vii to ice vi, and, owing to the absorption of heat, the atmosphere above it would be cooled. The red spot is, it is thought, "a manifestation at the visible surface of the thermal effects accompanying the change of phase".

Assuming further that the level at which the ice floats is subject to small variations, the radius of gyration about the axis of the planet will vary, and a simple calculation shows that a total range of 10 km. would account for all the changes in velocity that the red spot has undergone during the period of investigation. While ice and nitrogen illustrate very readily the hypothesis, it is pointed out that the phase diagrams of other substances, such as hydrogen and helium, also suggest suitable conditions, and it is unnecessary to assume that ice and nitrogen are actually responsible for the phenomenon. It is hoped that the matter will be investigated more fully in the near future.

[1] *Proc. Amer. Phil. Soc.*, **81**, 2 (1939).

POSSIBILITIES OF ALTERNATING CURRENTS FOR LONG-DISTANCE TRANSMISSION

IN the *Electrical Review* of October 20, H. Rissik shows that some of our early notions about the transmission of electric power must be modified. In the past no difficulty was at first experienced in utilizing the line conductors to the full extent of their carrying capacity. Transmission distances were short and the power to be transmitted amounted to only a few thousand kilowatts. As time went on and transmission voltages and distances gradually increased, the view became common that any technical limitation to the amount of power that could be transmitted was to be looked for in the nature of the generating plant and transformers, rather than in those of the transmission line itself. It was seen that there was no longer a definite line voltage for a given power and distance giving the lowest transmission costs, which diminished as the voltage that could be used increased. Other characteristics of the electric plant had to be taken into account.

The special problems created by the linking up of immense power networks operating at 132 and 154 kv. and in many cases at 220 kv., involving power interchange over long distances, first became acute in the United States, and they have also arisen in France, Germany and the U.S.S.R. To the pioneer work of American engineers we are indebted for our present knowledge of the essential factors which contribute to system instability. They have also developed methods of improving the stable operation of power systems. It is very creditable that individual electricity undertakings, operating on a very large scale, should have deliberately subjected their power systems to major electrical disturbances in order to verify calculations based upon a new theory. This form of large-scale experimentation was on several occasions undertaken in the United States, notably in 1928 on the 220 kv. system of the Southern California Edison Co. and again in 1930 on the 132 kv. system of the West Penn Electric Co.

As a result of the experience accumulated during the last ten years, it has become possible to investigate technically methods whereby the stability of superpower trunk lines may be raised to levels where economics once more becomes the decisive factor. It has been for a long time common practice to employ a synchronous condenser at the load end of a transmission line in order to maintain the terminal voltage common at all loads. In 1921 Baum showed that this principle could be extended to a long line divided into several sections and having synchronous condenser stations located at the points of section. Taken as a whole this transmission line acquires the electrical characteristics of its individual sections. As the result of the reactive power compensation effected by the intermediate condenser stations, the voltage at each point of section is maintained constant and equal to the transmission pressure.

Another system is the self-tuned line. To every frequency of alternating current there corresponds a wave-length, such that their product equals the velocity of propagation of the train of electric waves, just as in radio, television and carrier communication. For overhead lines, the velocity of propagation is approximately equal to the velocity of light, that is, about 180,000 miles per second, so that the wave-length of a 50-cycle transmission line would be about 3,700 miles. Skilling showed in 1927 that if the transmission distance is just half the wave-length at the applied frequency, the line inductance and capacity cancel each other out and the line behaves