trunk lines, has now been realized by M. Paul Laffont, the French minister of telegraphs and telephones. He proposes to invite a conference at Paris of the technical administrators of the western European countries, and he urges that France would naturally be the center of the vast telephone system formed by combining the systems of these countries. The long-distance telephone calls in daily use in America show that, from an engineering point of view, the scheme presents few difficulties. Thus the New York-San Francisco call (3,000 miles) is equivalent to communication between London and Baghdad; the Key West (Florida) and Los Angeles call *via* New York and San Francisco is equivalent to a London-Delhi communication.

THE Department of Commerce announces that provisional figures compiles by the Bureau of the Census for the first six months of 1922 indicate higher death rates than for the corresponding six months of 1921. For the states compared the death rate for the six months was 12.6 in 1922 against 12 for the first six months of 1921. The highest mortality rate for the half year is shown for Maine (15.7) and the lowest for Idaho (8.2). These figures forecast for the year 1922 a somewhat higher rate for the death registration area than the record low rate (11.6) for the year 1921. Provisional birth figures for the first six months of 1922 indicate lower birth rates than for the corresponding six months of 1921. For the states compared the birth rate for the first six months was 22.7 in 1922 against 24.8 in 1921. The highest birth rate for the half year (30) is shown for North Carolina and the lowest (18.1) for Vermont. Births so far reported for the first six months of 1922 indicate a lower birth rate for the year than the 1921 rate for the birth registration area (24.3).

UNIVERSITY AND EDUCATIONAL NOTES

A BEQUEST of $100,000 for the erection of a building for the department of mechanical engineering at the University of Maine, to be named for the donor, is made in the will of Oliver Crosby, head of an engineering firm in St. Paul, Minn.

BAKER UNIVERSITY announces a gift of $100,000 from Mr. Joab Mulvane, a retired banker of Topeka, Kansas, and a member of the board of trustees of the university. The money will be used in the erection of the Mulvane Science Hall.

THE faculty of Case School of Applied Science, Cleveland, Ohio, were notified in October of a new and advanced scale of salaries, which took effect at once. Full professors, of whom there are twelve, will receive $5,000; associate professors, of whom there are eight, will receive $3,300; assistant professors, of whom there are nine, will receive $2,800; and instructors, of whom there are thirty-three, will receive $2,000 to $2,200. The enrollment at Case this year is slightly less than a year ago, numbering 615, with a freshman class of 198.

SIR AUCKLAND GEDDES, British ambassador to the United States, and previously a distingushed professor of anatomy, delivered the address in dedication of the J. William White Surgical Pavilion of the University of Pennsylvania, on December 14. The pavilion is named after the late Dr. J. William White, who was for many years professor of surgery. It was built at a cost of $1,000,000, of which $350,000 was contributed by the state and the remainder by friends of the university.

PROFESSOR GEORGE DAVID BIRKHOFF, of Harvard University, has been appointed lecturer in mathematics at Yale University for the second term. He will give a course in the Graduate School during Professor Ernest W. Brown's absence.

LOUIS AGASSIZ FUERTES, the artist, has been appointed lecturer in ornithology in Cornell University.

DR. H. M. JENNISON, who recently received the degree of Ph.D. from Washington University, has been appointed associate professor of botany at the University of Tennessee, after having completed eleven years' service at the Montana State College.

DR. A. W. GIBB has been appointed to the

newly founded Kilgour chair of geology at Aberdeen.

Dr. Fritz Straus, of Berlin, has been appointed professor of chemistry at the Breslau School of Technology.

DISCUSSION AND CORRESPONDENCE

RADIATION A FORM OF MATTER

To the Editor of Science: One sees the statement frequently made that, if one accepts Einstein's conclusion that the mass of a body is proportional to the total energy which it possesses, the principle of the conservation of matter must be abandoned. For if during any change energy is gained or lost by the body through radiation, there should be a corresponding gain or loss of mass. It has been calculated that in the case of radioactive disintegration the energy thus lost (or gained) through radiation represents an appreciable fraction of the total mass of the radioactive material. If, however, one takes the point of view that radiation is a form of matter, and that the amount of this matter is measured by the mass or inertia of the radiation, the total mass of the body plus that of the radiation emitted is unaltered by such changes. On this view the principle of the conservation of mass is strictly valid, being, as has been remarked, a corollary of the energy principle.

It is perhaps surprising to notice that according to the definitions of matter usually given electromagnetic radiation must be classed as matter. It is admittedly difficult to find a satisfactory definition. "Matter is that which occupies space," "matter is that which possesses mass or inertia," "matter is that which affects the senses," are, however, common statements. But radiation certainly occupies space; that it possesses mass is shown by the momentum which it imparts to a body which it strikes, producing radiation pressure; and who would deny that sunlight affects the senses? Unless, therefore, we change our idea of what is meant by the word "matter," this word includes not only solids, liquids and gases, but also the less tangible electromagnetic radiation.

The inclusion of radiation as a form of matter has important bearings in addition to the fact that it renews the validity of the principle of the conservation of matter. Thus, for example, we can no longer say that matter is composed wholly of positive and negative electrons, for the form of matter known as radiation includes no such electric charges. The statement that matter is composed of positive and negative electrons and electromagnetic radiation is, on the other hand, more complex than is required. We see rather that the fundamental thing in matter is not the electric charge but the electromagnetic field, for the electromagnetic field includes both the electrons and the radiation.

If the further simplification is made of considering the magnetic field as due to the electric field in motion, we may describe all forms of matter in terms of the intensity of the electric field at different points. The mass or inertia of the matter is proportional to the integral through the volume considered of the square of the electric intensity and of the magnetic intensity resulting from the motion of the electric field, whether this electric field is due to the presence of electrons or to the existence of electromagnetic radiation. The electric charge in an element of volume is proportional to the divergence of the electric intensity at the point. Thus all the fundamental properties of matter are determined if the intensity of the electric field throughout space and time is known. While the electrons can not be considered the fundamental elements which make up all matter, we have thus the intensity of the electric field as that which can be thought of as composing both the electrons and the radiation. Electric intensity, then, may be considered as that of which all matter is composed.

According to this point of view, matter is perfectly continuous. It is true that there are certain perhaps limited regions, the electrons, from which electric intensity diverges; but whether or not these regions of divergence are limited, the mass of the matter is associated with the electric intensity and is hence distributed through all space. Similarly, radiation propagated through space, as for example light coming from the sun to the earth, is on this view a continuous series of waves of