spirit or with the stuffs of the mind, have eschewed sense and confined themselves to sensation. But their work has been so stupendous that all other men of all other studies have been set staring at their methods, imitating their way of thought, ogling their results." In discussing this he said: "Science does not need praise, nor does work need praise, they both need plain wages. I think it is time to urge a definition of Science which will help to purge the popular imagination: Science is the spirit of work. I do not mean the Spirit of a man who works, but I do mean simply that science has to do solely with the increasing efficiency of the sweaty labor of this world. I am little disposed to argue what many of you may be inclined to think an undue narrowness in this definition, but I assure you that it is wide enough for me.

"There is a tendency among reflecting men to confuse the boundaries between our logical constitutions and the objective realms which they represent to the understanding. Münsterberg thinks that this is the gravest danger of our time. I do not fully agree with this, but I do agree with President Wilson in seeing in this confusion of boundaries the effects of a noxious gas which has somehow got into the lungs of other men from out of the crevices of our workshops, a gas, it would seem, which forms only in the outer air and where men do not know the right use of their lungs.

"This confusion of boundaries is to my mind a new species of idolatry. The old idolatry is the worship of form, and this new idolatry is that contemplation of our logical constructions which despises objective constraint. Now, I cannot see that we, as scientists, are in any degree responsible for this disservice, this working of a great degeneracy among men, but, as individuals, I think most of us are guilty of more or less frequent and flagrant lapses of that submission to objective constraint which is the very essence of moral quality in scientific work.

"There is, of course, a legitimate sphere of scientific speculation of a certain kind, but the purely suggestive and highly tentative efforts in this line should not be confused with the more substantial work of science, and this is precisely what happens in the popular imagination. The majority of men do not appreciate the difference between a discussion of the motion of stars in the line of sight, based upon spectroscopic measurements, and a discussion of the habitation of Mars, based on nothing at all! Idle speculation is the last infirmity of strong minds, but it is certainly the first infirmity of weak ones, and popular science is, I think, primarily speculation.

"The extent to which some of our elementary text books in physics indulge in weak phases of speculation is very surprising to me, for, in this connection, it is absolutely out of place and entirely misleading. What do you think, for example, of the following quotation from Maxwell as a help to clear up an inadequate definition of energy in a secondary school book in Physics? 'We are acquainted with matter only as that which may have energy imparted to it from other matter, and which may in its turn communicate its energy to other matter. Energy, on the other hand, we know only as that which in all natural phenomena is continually passing from one portion of matter to another.' What do you think of the following, from an elementary English text book? 'The fundamental property of matter, which distinguishes it from the only other real thing in the universe, is inertia. . . We are now in a position to give one or two provisional definitions of matter—provisional, because we cannot yet say, possibly may never be able to say, what matter really is. It may be defined in terms of any of its distinctive characteristics. We may say that matter is that which possesses inertia, or, again, since we have no knowledge of energy except in association with matter, we may assert that matter is the vehicle of energy.' I wonder if any of you really doubt that every notion in physics, definite or indefinite, is associated with and derived from a physical operation, and that absolutely the only way to teach physics to young men is to direct their attention to that marvelous series of determining operations which bring to light those one to one correspondences which constitute the abstract facts of physical science. If you do, I am bound to say I do not think much of your knowledge of teaching of physics. I think that the sickliest notion of physics, even if a student gets it, is that it is 'the science of masses, molecules, and the ether.' And I think that the healthiest notion, even if a student does not wholly get it, is that physics is the science of the ways of taking hold of bodies and pushing them!"

Two public lectures, complimentary to the citizens of Washington, were presented by members of the Association. The first of these was on the Volcanoes of the West Indies, and was given by Prof. Israel C. Russell, who visited Martinique and adjacent islands at the time of the Mont Pelee disaster. The second was on King Solomon's Mines, or the Mines of Ophir, by Mr. John Hays Hammond, the distinguished mining engineer. Both of these lectures were illustrated by lantern slides and attracted considerable attention.

Two items of business of more than common interest are worthy of mention in this brief report. The first of these has reference to the death of Major Walter Reed, who, by solving the problem of the mode of spread of yellow fever not only made a great contribution to science, but at the same time conferred inestimable benefits upon his country and upon mankind. A suitable and permanent memorial of this great benefactor of his race was advocated, and a committee, consisting of the following members, was appointed by the president to take charge of the matter: Dr. D. C. Gilman, Dr. A. Graham Bell, Gen. George M. Sternberg, Mayor Seth Low, Hon. Abram S. Hewitt, President J. G. Schurman, Dr. S. E. Chaille, Dr. W. H. Welch, Dr. Charles S. Minot.

In addition to the foregoing, a resolution, asking that the President appoint as a member of the Isthmian Canal Commission a medical expert, so that special knowledge, based upon the practical familiarity with tropical diseases and experience in the application of sanitary measures, might be used to prevent the enormous loss of human life likely to occur from preventable diseases, particularly pernicious malaria and yellow fever.

The total attendance of the Washington meeting was 985, which makes it second only to the meeting held in Boston in 1880, when there were 997 persons present. An attempt was made to secure the number of persons in attendance at the meetings of the affiliated societies, and 363 of such registered, so that the attendance may be comparatively estimated at being not less than 1,500, which figures warranted the statement that "it was the largest gathering of scientific men ever held on this continent." There were 372 persons elected to membership, as well as a large number of members advanced to the grade of fellowship.

Following the practice of recent years, the invitation to meet in St. Louis, presented to the council at Pittsburg, was accepted, and it was voted to meet in that city during Convocation Week, 1903-4. The Hon. Carroll D. Wright, the well-known authority on economics, and a member of the recent strike commission created by President Roosevelt, was elected president, and Dr. Charles Wardwell Stiles, of the Marine Hospital Service, was chosen secretary. For further account of this meeting, the reader is referred to the current SUPPLEMENT.

The Current Supplement.

The English correspondent of the SCIENTIFIC AMERICAN opens the current SUPPLEMENT, No. 1411, with a discussion of the well-known Babcock-Wilcox boiler; his text is illustrated with photographic and sectional views. One of the most interesting features of the SUPPLEMENT is a diagram prepared by the Bureau of Naval Intelligence for the purpose of giving a graphic representation of the homogeneity of the different classes of battleships of the principal naval powers, the idea being to show at a glance how these navies are carrying out a plan of building ships in classes, keeping down, as far as possible, the number of different types. The canal problem of New York State is discussed in the light of Governor Odell's recent message. Mr. Marcus Benjamin gives an abstract of the proceedings of the fifty-second meeting of the American Association for the Advancement of Science.

The discussion of American methods of irrigation begun in the last SUPPLEMENT is continued.

A monument was recently unveiled with great ceremony, near Junction City, Kan., to mark the supposed site of the famed city of Quivira, which the natives of that section think lies buried beneath their feet. The obelisk is the contribution of the members of the Quivira Historical Society, who are scattered through Kansas, Minnesota and other Northwestern States, the leading spirits of which organization are J. V. Bower, of St. Paul, Minn., who claims to be the rediscoverer of Quivira, and Robert R. Henderson, of Junction City. The location and even the existence of Quivira has been an active subject of discussion for a hundred years, and much has been written on the subject. It has been located at different times at various places in Mexico, Arizona, and other parts of the Southwest, but this is the only location which can lay claim to a substantial monument to mark its supposed site. Those who doubt the existence of the "City of Gold," as Quivira is spoken of, say that the Indians who were supposed to have peopled the city, and who bore the same name, were the poorest tribe known to history.

An International Fire Exhibition will be held at Earl's Court, London, from May to October next. Besides fire extinguishing and life saving apparatus there will be exhibited examples of modern fire stations and water supplying plants and their equipment in every form, ambulance and hospital facilities for cities, salvage work, and insurance.

Correspondence.

Do Mussels Move?

To the Editor of the SCIENTIFIC AMERICAN:

I do not pose as a scientist, and yet the question: "Do Mussels Move?" that has been going the rounds of the country press, and has found its way into the SCIENTIFIC AMERICAN of this date, has both amused and surprised me—a Missouri boy—and I suppose has surprised all Missouri boys who have lived near a stream.

The smooth thin-shelled mussel lives in the streams on the sandy bottom. The corrugated heavy-shelled mussel lives in the mud and is the commercial mussel, i.e., the shell from which buttons are made.

Often in clear water one can see the smooth-shelled mussel on edge with a trail or track behind it that may extend one or six feet. The side opposite the hinge is slightly open, and the mussel protruding a quarter of an inch, is feeding. Its lips, belly or feet are corrugated like the belly of a snake, and with the exception of the mussel's movement being in a straight line, is identically the same, being propelled by contraction and expansion.

When a large stream is full and causes "back water" in the smaller streams, and then recedes rapidly, the life habits of the large, heavy mud mussel are just as easily seen.

When a mussel is moving, if it is picked up quickly and squeezed, it draws back into the shell, and a fine stream of water will be forced out, like the water from the tube of a muzzle-loading gun when being cleaned.

The iridescent coloring of the inner side of the thin-shelled mussel is as fine as that of any sea shell.

Monroe City, Mo., Jan. 3, 1903. R. F. HIXSON.

The Cause of Thunder.

To the Editor of the SCIENTIFIC AMERICAN:

At the risk of advancing a theory which may have been already proven by meteorologists, I wish to make a suggestion in regard to the cause of thunder.

Upon inquiry among the men with whom I am associated, I find that our various colleges have given us all practically the same instruction on this point, namely, that thunder is due to the closing up of a vacuum formed in the air by the passage of the lightning, supposedly owing to the violent mutual repulsion of similarly electrified molecules. If this is correct, we have only the pressure of the air at 15 pounds per square inch to account for the deafening roar of a thunder peal.

Furthermore, it is taught that the report of a gun is due to the concussion of the air rushing into the bore after being expelled by the explosion of the cartridge.

Would it not be more reasonable to suppose that thunder is due to intense heating of the gases along the line of the electric discharge, and the consequent conversion of any suspended moisture which may be present into steam at enormous pressure, the effect being that of a violent detonation or blow upon the surrounding air?

In the case of the gun, is it not easier to believe that the gases which escape from the muzzle at a pressure of from 5 to 15 tons to the square inch have more part in causing the loud report by the blow they strike on the air than the subsequent recoil of air into the bore at the insignificant pressure of 15 pounds.

Since the density of the air is nearly uniform, the teaching of the schools would seemingly render no explanation of the great variation in quality and volume of sound noticeable in almost every peal of thunder. Frequently there are three phases, the first a sharp crackle sometimes prolonged for nearly a second, the next a heavy rumble punctuated by periodic louder reports, and third, though not always, a single earth-shaking explosion.

Following my line of thought the crackling noise would be due to steam explosions on a small scale caused by slight electric discharges (possibly induced) which precede the main bolt. The second phase would be due to a series of overlapping steam explosions generated by the main bolt, the occasional louder reports being due to the belts of drier air traversed by the lightning, in which increased resistance would be encountered, the temperature and steam pressure increasing proportionately, despite the presence of less water particles. The final report would be loudest in case it occurs at the point of the flash nearest the observer, as in a vertical discharge from the clouds to the earth. When the charge passes from the earth to the clouds the nearest point in the flash would be its beginning, and the observer would hear a loud report followed by a series of lighter ones, as is frequently the case. When the flash leaps from cloud to cloud the thunder would be a long roll or series of concussions, indistinguishable, or nearly so in point of loudness.

ROBERT V. R. REYNOLDS, Assistant Forest Expert.
Silkhope, S. C., January 14, 1903.