tube. The commoner, non-liquefying form appears to have been found by Laws and Andrewes in the sewage of St. Bartholomew's Hospital in 1894 (Report to the London County Council on the 'Micro-organisms of Sewage'). Still earlier Roscoe and Lunt ('Contributions to the Chemical Bacteriology of Sewage,' *Phil. Trans. Roy. Soc. London,* CLXXXII., 1891, not CLXXXIII., 1892, as given by Chester) described under the name *Streptococcus mirabilis* a form which developed best without air, gave faint growths on gelatin and agar, and formed a cottony mass at the bottom of the broth tube. These organisms are all closely related to each other, as well as to the *Streptococcus pyogenes* of Rosenbach; and until more detailed systematic study of the group is made, the common sewage forms may perhaps best be known provisionally as the 'sewage streptococci of Houston,' since he first called attention to their sanitary significance. We feel convinced that this group may prove of the greatest assistance to bacteriologists in this country, as it has done already in England, and that record of its presence or absence should be made in any sanitary bacteriological water analysis.

C.-E. A. WINSLOW.
(MISS) M. P. HUNNEWELL.
BIOLOGICAL LABORATORIES,
MASS. INSTITUTE OF TECHNOLOGY,
May 8, 1902.

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*THE METRIC SYSTEM OF WEIGHTS AND MEASURES.**

THE Committee on Coinage, Weights, and Measures, to whom was referred the bill to adopt the weights and measures of the metric system as the standard weights and measures of the United States, having duly considered the same, respectfully report as follows:

By Section VIII. of Article I. of the Constitution power is vested in Congress to fix the standard of weights and measures, and yet, strange as it may appear, this is about the only great and important subject intrusted to its care by the express provisions of the Constitution which has been almost wholly neglected. Again and again has the necessity for a change in our system of weights and measures been urged upon the attention of Congress. Washington more than once pointed out the importance of securing a uniform system of weights and measures, and early in the history of our country the matter was referred to Jefferson, then Secretary of State, who proposed two plans, one an adaptation of the existing system and the other a strictly decimal system.

John Quincy Adams, as Secretary of State, after four years of careful study, made a report which is worthy of the attention of the most advanced thinkers upon this subject at the present day. He pointed out the failure of the English people to reduce to any sensible order the chaos of their weights and measures and urged upon Congress the necessity for a reform. He, however, advised delay until the metric or international system, which was then in its infancy, had been more fully tried, and to which he referred in a most glowing tribute as possessing all of the requisites of a simple, uniform, and workable system of weights and measures.

Since that time the adoption of the metric system has been repeatedly recommended by the departments of the Government and Congressional committees. The annual report of the Secretary of the Treasury for the year ending June 30, 1899, contains the following clear and concise statement:

* Report submitted by Mr. Southard, from the Committee on Coinage, Weights, and Measures, to the House of Representatives on April 21. The text of the bill recommended is as follows: *Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That on and after the first day of January, nineteen hundred and four, all the departments of the Government of the United States, in the transaction of all business requiring the use of weight and measurement, except in completing the survey of public lands, shall employ and use only the weights and measures of the metric system; and on and after the first day of January, nineteen hundred and seven, the weights and measures of the metric system shall be the legal standard weights and measures of and in the United States.

The intense commercial rivalry of nations warns us to leave nothing undone which might further our own interests, and there can be no doubt that the introduction of the metric system, to which this country stands pledged since the meeting of the International American Conference in 1890, would greatly facilitate international commercial transactions. Without doubt Great Britain and Russia would follow the initiative of this country in this matter, and thus, what a few decades ago would have been considered an unattainable ideal, namely, a system of weights and measures common at least to all western nations, would be reached.

It is not the purpose of this recommendation to place before Congress a full discussion of this subject. The various committees appointed by it from time to time to consider this matter have made exhaustive reports covering aspects of the question no less important than the commercial one—reports always agreeing on the necessity for reform, always considering our present system a temporary one and out of harmony with our decimal notation and monetary system, and since 1866 always recommending the introduction of the metric system.

The great difficulties which seemed to stand in the way appear to have been over-rated, for its introduction into Germany, Austria, and other European countries was accomplished with little or no confusion. This Government, therefore, would not enter upon an untried experiment if its obligatory introduction in all governmental affairs was ordained, as it has been in the countries named.

The subject of a reform of our system of weights and measures engaged the attention of Washington, Jefferson, Madison, and Adams, and in Congress the reports of Messrs. John A. Kasson in 1866, Alexander H. Stephens in 1879, and Charles W. Stone in 1896 and 1898 advocated the introduction of the metric system.

Among my predecessors, Robert J. Walker, in 1847, urged it upon Congress, Secretary Chase gave it his support and Secretaries Windom and Foster successively concurred in the favorable recommendation of Secretary of State Blaine. Secretary Carlisle adopted as fundamental standards for the Treasury Department the metric standards prepared at the International Bureau of Weights and Measures, an establishment maintained by the principal nations of the world. The various States of the Union were, by the action of Congress in 1866, supplied with copies of the principal metric standards.

All these facts exhibit a consistent endeavor on the part of the executive as well as the legislative branches of our Government, from its foundation to the present time, to reform our heterogeneous metrology.

As the present time seems most opportune and the matter of great importance, it is recommended that Congress take such action as will bring about the desired end.

The delegates of the United States to the Pan-American Congress were instructed in 1889, by the Secretary of State, as follows:

1. That the desirability of promoting the establishment of an international system of weights and measures be recognized as a principle of action in legislation.

2. That the decimal or metric system shall serve as the basis of unification.

3. That all nations, not already parties to the convention signed at Paris, May 20, 1875, establishing an International Bureau of Weights and Measures, shall become parties thereto.

4. That the aggregate statistics of international commerce shall be, where it is not yet being done, published also in metric equivalents.

5. That all invoices shall be made out in metric weights and measures, where weights and measures appear, as far as they relate to the commerce between the nations participating in this congress, and that the table of equivalents herewith shall be recognized as legal by the nations taking part in this congress, in converting the customary weights and measures of the United States into metric weights and measures in making such invoices.

6. That metric weights be used exclusively in the mints.

These are but a few of the recommendations that have been made by the officers of the Government and others in authority from the beginning of the Republic to the present time. To these must be added the efforts of many of the best men of the country in all lines and professions, scientific societies, commercial and manufacturing organizations, who have striven to bring order out of chaos, and who have recognized the value and importance of a suitable system of weights and measures to every interest of the country. While these efforts have met with practically the unanimous approval of all who have given the sub-

ject any attention whatever, the failure of these efforts to bring about the adoption of a better system of weights and measures has been due to the willingness with which many would rather endure a present evil than submit to a temporary inconvenience for the benefit of the present and future generations.

THE WEIGHTS AND MEASURES IN COMMON USE.

A complete list of the weights and measures in common use would be difficult to make and would involve much space. The various units have been inherited from a time when exact measurements were unheard of, computations were seldom made, and when each locality and different interest had its own system of measures. Modifications and adjustments have been made from time to time; nevertheless it is still full of inconsistent ratios, difficult to learn and still more difficult to remember. The units are not related to each other; many units of the same name have entirely different values. It is unsuitable for computation, and is not decimal in character. The advantages to be gained by the adoption of the metric system as compared with the one in present use are far greater than the benefits derived from the adoption of a decimal system of coinage in place of the English monetary system.

It is a popular fallacy that our weights and measures are in accord with those of Great Britain, but this is not true, as neither our pound, yard, gallon, or bushel is identical with the corresponding English unit.

Very few people are familiar with the weights and measures in common use in the United States. One has but to recall the tables of our three different systems of weights, the apothecary, troy, and avoirdupois, to illustrate this fact. And while the yard may be stated as our standard of length, we find in practice various arbitrary multiples of the yard and foot; for example, the fathom, the surveyor's and engineer's chains and links, the nautical and statute miles, hands, poles, perches, and various others. In addition to the ordinary cubic measure, we find three systems of measuring capacity, dry measure, liquid measure, and apothecary's fluid measure. To these might be added a large number of technical standards in use in the various trades and industries in common use which would be greatly simplified and unified upon the adoption of the international system of weights and measures. An examination of the tables of our weights and measures discloses the fact that there are sixty-four different ratios used, of which nineteen are not divisible by 2, and that there are eighteen terms used which have two or more meanings. Certainly any effort to replace this conglomerate system with a simple, logical one, similar to our monetary system, is worthy of the consideration of Congress.

THE METRIC OR INTERNATIONAL SYSTEM.

The metric system of weights and measures was devised as an international system. The fact that it was first adopted by France has given rise to the custom of referring to it as the French system. It is interesting to note, however, that one of the first to propose a decimal system of weights and measures was James Watt, the inventor of the steam engine. The adoption of a decimal system of coinage by the United States was one of the strongest influences leading to the adoption of the metric system by France. The unit of length in the metric system is called the 'meter' and was defined as the one ten-millionth part of the distance from the equator to the pole of the earth measured on a meridian. The first of these units to be constructed was by the French Government, and was based on the best known measurement of the earth's surface at that time.

An international congress was held in Paris in 1875 for the purpose of improving the standards. Accordingly a number of meters were constructed of the best material and by the best methods known to science. One of these was selected as the international standard of length and is very carefully preserved at the international bureau of weights and measures established and maintained by the countries participating in the congress and those which have joined the convention since. These meters were very carefully compared with the one selected as the international

standard and then distributed to the countries interested. The unit of mass or weight, as it is commonly called, is the 'kilogram,' and is defined as the mass of a cubic decimeter of pure water at a standard temperature. The international committee also prepared forty pieces of metal equal in mass to that of the cubic decimeter of water, alike in form and of the same material as the standard meter, the most permanent metal known. One of these was retained at the International Bureau of Weights and Measures as the international kilogram.

The same precautions were observed in the comparisons with each other and with the one selected as the international standard before distributing them to the respective governments. Of the two meters and two kilograms sent to the United States one of each is preserved as the national standard of length and mass. The others are taken as working standards, and serve as the basis of all comparisons of length or mass in this country. The fact that the meter is only approximately a natural standard as originally intended has sometimes been used as an objection to the metric system. This, however, is of little importance, since the meter and the kilogram as constructed are as permanent as it is possible to make material standards and are far more accurate than any measurements that can be made of the earth's surface. If at any time a suitable natural standard should be discovered, the meter would simply be defined in terms of that standard as it originally was in terms of the earth's quadrant.

The advantages of the metric system may be briefly stated as its decimal character throughout, the simple relations between the units making it possible to derive all others directly from the unit of length, its elasticity (being equally convenient for the measurement of the smallest or largest objects), the ease with which it is learned and remembered, the saving of time, and the increased accuracy with which computations may be made. These advantages have been proven by a century of use, but that which especially commends it to us at the present time is its international character, since it is the opinion of all who are in a position to know that the world must soon come to an international system of weights and measures, and that there is not the slightest possibility of our own system or any modification of it becoming universal.

THE METRIC SYSTEM AS USED IN SCIENTIFIC WORK.

Scientific investigators early recognized in the metric system of weights and measures a simple, flexible system equally suitable for the most refined or coarsest measurements, or for purposes of computation. As a result the scientific world to-day enjoys the advantages of a universal system of weights and measures, a fact which has greatly facilitated the development and spread of scientific knowledge. The practical applications of scientific work have in many cases been seriously handicapped or retarded owing to the necessity of converting formulæ derived in the metric system to equivalent formulæ in the common system. If the formulæ and other data used in manufacturing and engineering were universally expressed in the metric system, it would greatly promote the growth and dissemination of such knowledge throughout the entire world.

BENEFITS TO BE DERIVED BY EDUCATIONAL INTERESTS.

The benefits to be derived from the adoption of the metric system by the educational interests of the country are perhaps the most important that have been brought to the attention of this committee. Estimates made by the Department of Education and others show that the work of at least two thirds of a year in the life of every child would be saved by the adoption of the metric arithmetic. The British Parliamentary committee having in charge a similar investigation estimated the saving of time at one year. This is a matter the importance of which can hardly be overestimated, taking into consideration the large amount of work to be covered in the curriculum of the schools and the enormous sums annually devoted to educational work. The metric system is taught in nearly every school in the country. Teachers and pupils alike unanimously testify as to the ease with which

the system is taught and learned and the facility with which it is applied to the problems which in ordinary arithmetic are complex and difficult to solve. When we consider that there are over 15,000,000 school children in the United States being educated at a public cost of not less than $200,000,000 per year, the enormity of the waste will be appreciated. In the lifetime of a single generation nearly $1,000,000,000 and 40,000,000 school years are consumed in teaching a system which is in harmony with that of no other nation of the world.

In higher education the metric system of weights and measures is used almost exclusively, and attention is called to the action of the associated academic principals of the State of New York—a body of some 700 high school principals, superintendents and prominent educators—which has passed the following resolution in regard to the adoption of the metric system:

Resolved, That we hereby instruct our legislative committee to forward to Congress of the United States, if there shall be suitable occasion and opportunity, our earnest petition for the enactment of such legislation as shall render the use of the metric system obligatory throughout the United States.

Many similar actions by educational bodies of all kinds throughout the country have been called to our attention.

It is a matter of evidence on the part of educators in the United States, Great Britain, and Continental Europe that the metric system and its application to the solution of problems may be learned in one tenth the time required for gaining an equal facility in the use of the English system of weights and measures. It is doubtful whether any measure of more vital importance and benefit to the educational interests of the country has ever come before Congress.

RELATIONS TO MANUFACTURING INTERESTS.

It should be emphasized that this measure in no way contemplates any change in existing technical standards, such as screw threads, wire gauges, lumber measures, and numerous others, except as manufacturers and other interests involved find it to their interest to make the change. Doubtless a change in the fundamental standards of length and mass would facilitate the simplification of such standards; but the changes would still be brought about as heretofore by the special interests involved.

Any change in the standards employed in manufacturing, no matter how perfect the systems proposed or how beneficial the change may be, must be very carefully and judiciously made. In the case of textile fabrics, materials of construction, package goods, and almost all kinds of manufactured products, a change would no doubt involve some inconvenience, but the expense of modifying existing plants or machinery would be very slight. In many cases no change or expense would be necessary, and the benefits to be derived from a convenient and universal standard would far more than compensate for the expense and confusion temporarily involved during the transition stage.

The relation between the manufacture and the sale of these products is so close that any change in the system of weights and measures which will lessen the burden and expense of the counting room and office is worth the cost, considered from the standpoint of economy alone. The action of many associations of manufacturers and merchants, both in the United States and in Great Britain, has been called to our attention, and without exception they have urged the adoption of the metric system of weights and measures, on account of its international character and superiority over the present system for manufacturing and commercial purposes.

In no other country has the construction of machinery reached a degree of perfection superior to that of our own, a result principally due to the system of interchangeable parts. The latter may be said to be a product of American ingenuity and to be the greatest single advance in modern machinery. It has for its essential features a uniform standard of length and accurate length-measuring instruments. This work has been done upon the basis of the inch, which in many cases has been decimalized.

There are a few who claim that the inch is better suited for this purpose than the units of the metric system. However, it should be kept in mind that the interchangeable system does not depend upon the unit used, but upon uniform, reliable standards and accurate measurements, and it is difficult to see why the inch and fractions of an inch should be superior to the centimeter and decimals of a centimeter. German, French, English, and American manufacturers are successfully manufacturing upon a metric basis and have shown no desire to return to the old system, notwithstanding the fact that the change has been made in the latter cases under very adverse circumstances.

It is admitted that the temporary inconvenience caused in the shop and drafting room by the proposed change would be very serious if suddenly brought about, but any measure which contemplates only the gradual introduction of the one system for the other, or even the continuation of the old by all except the departments of the Government in case it is desired, can not be said to be compulsory or capable of producing more than a minimum of inconvenience or expense, and certainly an interchangeable system upon an international basis will be superior to one based on the standard of a single country.

THE NECESSITY FOR THE METRIC SYSTEM IN COMMERCE.

The enormous development of the commerce of the United States within recent years has brought to the attention of our merchants and business men the great advantages to be derived from the adoption of an international system of weights and measures. The use of the old system not only involves great loss of time in making computations, but places our merchants at a great disadvantage in dealing with countries which have already adopted the international system.

More than sixty per cent. of our commerce is now carried on with countries using the weights and measures of the metric system, and it is evident that the commerce of the world must soon conform to the metric basis.

Theodore C. Search, president of the National Manufacturers' Association of the United States, states as follows:

Wherever manufacturers undertake to extend their trade in foreign countries, they encounter the metric system, and it is the only system of absolute uniformity which prevails throughout the world. The pound, the quart, the gallon, the ton have varying values, wherever encountered in foreign countries, and to insure accuracy the use of these units requires further explanation and some qualifying description in order to indicate just what quantity is meant. The enormous growth of our export trade during the past four years has brought our manufacturers in touch with the outer world as never before, and has given very practical illustration of the cumbersome character of our methods of measurement, and the advantages to be derived from the adoption of a system which is absolute and uniform throughout the world. * * *

And as we have only just entered upon a commercial conquest of the world, the utility of the metric system will become more and more apparent and the necessity for its adoption more urgent with each year of our growing export trade. The extension of our governmental functions to the Philippines, Cuba and Porto Rico brings into the circle of our commercial operations millions of people to whom the metric system is the recognized standard and to whom our own cumbersome system of weights and measures is a strange and unknown language of trade.

We recognize that any effort to supplant our present system of weights and measures with the metric system will be attended with more or less difficulty, and will involve some trouble for many of our manufacturers, because of the necessity of changing drawings, patterns, and standards, but we believe it entirely possible to accomplish such a change by gradual steps, and there should be no necessity for causing loss or injury to any of our industrial interests.

It seems to me that every argument is in favor of the unification of standards of weights and measurements throughout the world, and for us to insist upon an adherence to our antiquated standards is not in accord with the progressive nature of our people and the progressive tendency of this age.

Mr. W. O. Wilson, director of the Philadelphia Commercial Museum, states as his belief that 'millions of dollars are lost every year in transporting our weights, measures, and money from that of one country to an-

other in our international business relations.'

The testimony of Mr. Godfrey L. Cabot, a prominent merchant of Boston, includes the following statement:

Wherever this great improvement has gone, it has simplified the ordinary commercial transactions of daily life, minimized disputes, and given an absolute standard from which there could be no appeal and in which there was the least possible danger of error or misunderstanding.

RELATION OF THE METRIC SYSTEM TO TRADE.

The necessity for an improvement in the weights and measures of the country is nowhere more apparent than in the ordinary business transactions of daily life. Grain and produce are bought and sold by capacity measure, the bushel, peck and quart. The necessity for handling these commodities in large quantities by weight has resulted in the adoption of different weights for a bushel for the same commodity in different parts of the Union, and in a few of the Western states the hundredweight is used instead of the bushel. The diversity in this respect is so great that a correct table of the number of pounds to the bushel of different commodities for the several states is difficult to procure.

The long, short, and gross tons, without any distinction in name, are used in the buying, selling, and transportation of coal, ore, metals, and other heavy products. For liquids in large quantity the barrel used has many different values, and we find in common use often side by side avoirdupois weights, troy weights, apothecary weights, and the weights of the metric system. To add to this confusion the subdivisions of the ordinary measures are often not adhered to. The engineer uses the foot and tenths of a foot instead of feet and inches; the manufacturer, inches and decimals of an inch instead of adhering to the binary division; the gauger uses gallons and tenths of a gallon. In the handling of bullion we find troy ounces and thousandths of an ounce instead of ounces and grains. The engineer has discarded the inch, while some manufacturers of machinery have discarded the foot, hence we find tenths of a foot and the inch in common use. These are but a few of the instances where the introduction of the metric system would not only afford the advantages of a decimal system but furnish a system sufficiently elastic for all purposes. The experience of other nations has shown that the confusion and inconvenience caused by a change in the measures used in daily life was largely overestimated, and in no case have the people expressed a desire to return to the former system of weights and measures.

CONCLUSION.

The countless transactions involving the use of weights and measures make any proposition involving a change a most important one. The decimalization of our own system of weights and measures has been proposed by a few who have failed to consider the importance of an international system and the utter impossibility of the rest of the world adopting such a system as our own, however it may be improved in form. A change of this sort would be incomparably more radical than the adoption of the metric system. It has also been proposed to modify the existing system to one having a base of eight or twelve on account of the possibility of continued binary subdivision, but here again not only is the importance of an international system overlooked, but the impracticable idea is proposed of combining such a system with a decimal system of numbers. When the base of our system of numbers is changed to some other than ten it will be sufficient time to talk about a system of weights and measures having the same base.

It should also be kept in mind that the metric system is just as capable of a binary subdivision as any other, although the advantages of such a division are only apparent in the most ordinary business transactions, and for the first few subdivisions. After the adoption of the metric system, the use of the half and quarter meter and half and quarter kilogram would be as common as our half and quarter dollar—smaller quantities would be expressed in decimals precisely the same as in the case of our money.

In 1866 Congress legalized the metric system. From that time on it has been growing in favor and in practical use. It is here to

stay, not only in scientific work, but in commerce and manufacturing. It is now used by about two thirds of the people of the world. Russia, Great Britain and the United States are the only nonmetric countries. Russia has gone so far in the direction of its adoption that it may well be excluded from the list, leaving Great Britain and the United States. In both of these it has been legal for some time. Indications are that Great Britain will soon join the list of metric countries. Over 300 members of Parliament have already signified their willingness to vote to make the use of the metric system compulsory.

Your committee believe the time has come for the gradual retirement of our confusing, illogical, irrational system and the substitution of something better. The first step in this direction should be the introduction of the metric weights and measures into the departments of the Government. The use of these weights and measures will simplify their work. It will familiarize the people with them and encourage their application to the common affairs of life. Your committee have no doubt that the benefits to be derived will far more than compensate for such inconvenience and expense as may be involved in the change.

Your committee have amended said House bill 123 in line 4 by striking out the word 'three' and inserting in lieu thereof the word 'four'; also in line 9 by striking out the word 'four' and inserting the word 'seven.'

As thus amended your committee earnestly recommend the passage of the bill.

NATIONAL GEOGRAPHIC SOCIETY NOTES.

President A. Graham Bell has appointed General A. W. Greely Chairman of the Committee on the eighth International Geographical Congress which will meet in Washington in 1904 under the auspices of the National Geographic Society. General Greely was the delegate of the Society and also of the United States Government to the Geographical Congress which met in Berlin in 1899 and also to the Congress that met in London in 1895.

Dr. Israel C. Russell, Professor of Geography in the University of Michigan, has been elected a member of the Board of Managers of the National Geographic Society. Professor Russell is one of the three members of the expedition sent by the National Geographic Society to Martinique and St. Vincent.

The corner stone of the Hubbard Memorial Building which will be the home of the National Geographic Society in Washington was laid on April 26 by Melville Bell Grosvenor, the great-grandson of the late Hon. Gardiner Greene Hubbard, the first president of the Society. It is hoped that the building which is being erected at a cost of $60,000 will be ready for the Society by January 1, 1903.

The National Geographic Society has decided to act as trustee for Mr. Borchgrevink for his proposed American expedition to the South Pole. Mr. Borchgrevink proposes to start in the summer of 1903 and will leave the scientific direction to the National Geographic Society.

At a recent meeting the National Geographic Society has instituted a change in its By-Laws and created a body to be known as 'fellows.' 'Fellows' of the Society will be limited to those persons who are actively engaged in geographic work.

EXPEDITION TO MARTINIQUE.

The National Geographic Society has sent on the *Dixie* three geographers to make a special study of the recent volcanic eruptions. The Society has chosen three of its members, Professor Robert T. Hill, of the U. S. Geological Survey, Professor Israel C. Russell, of Ann Arbor, Michigan, and C. E. Borchgrevink, the noted Antartic explorer, to proceed to the scene of the disturbance to make a careful examination of conditions there.

Professor Robert T. Hill is acknowledged as the foremost authority on the West Indies in this country. He has written many scientific reports and books on Cuba and Porto Rico; has visited Martinique and St. Vincent, and for a long time has predicted the present eruption. Professor Israel C. Russell, head of the department of geography in the University of Michi-