DEPARTMENT OF COMMERCE AND LABOR

CIRCULAR

OF THE

BUREAU OF STANDARDS

S. W. STRATTON, Director

No. 29

ANNOUNCEMENT OF A CHANGE IN THE VALUE OF THE INTERNATIONAL VOLT

[1st Edition]
Issued December 31, 1910

WASHINGTON
GOVERNMENT PRINTING OFFICE
1910

Dr. E. B. Rosa;
Chief Division

1. Should the publication referred to below be reprinted?

Ans. No

2. Are there errors which should be corrected in next edition?

Ans. ~~Dr Dellinger's paper circular on El Units & Standards~~

3. If not to be reprinted, what publication, if any, will supercede it?

Ans. Dr Dellinger's circular on El. Units & Standards

The following data is submitted for your information:

PUBLICATION: SP TP CIR No. 29

TITLE: Announcement of Change in Value of International Volt.

AUTHOR:

ON HAND AT BEGINNING OF CURRENT MONTH: Exhausted.

PRESENT RATE OF USE PER MONTH: no record

PRESENT STOCK MAY LAST UNTIL:

As soon as you reach a decision and fill in the answers, please return this blank to Mr. Hubbard.

S

DEPARTMENT OF COMMERCE AND LABOR

CIRCULAR

OF THE

BUREAU OF STANDARDS

S. W. STRATTON, DIRECTOR

No. 29

ANNOUNCEMENT OF A CHANGE IN THE VALUE OF THE INTERNATIONAL VOLT

[1st Edition]
Issued December 31, 1910

WASHINGTON
GOVERNMENT PRINTING OFFICE
1910

ANNOUNCEMENT OF A CHANGE IN THE VALUE OF THE INTERNATIONAL VOLT.

On January 1, 1911, the Bureau of Standards will adopt a new value for the electromotive force of the Weston normal cell, namely:

$$E = 1.01830 \text{ international volts at } 20^\circ \text{ C.}$$

This is equivalent to an increase of about 0.08 of one per cent in the value of the international volt. The change will affect to a slight extent all measurements of electric current, electromotive force, and power, and will in some cases require slight changes in electrical measuring instruments. Some little inconvenience at least will thus be caused, and it is therefore important that the necessity for the change and the consequences of it be fully explained.

The International Electrical Congress, which met in Chicago in 1893, was composed of delegates from the United States, Canada, Great Britain, France, Germany, Italy, Austria, Switzerland, Sweden, and Mexico. In addition to adopting formal definitions for the principal electrical units of measure the congress fixed the numerical magnitudes of the three fundamental units which enter in Ohm's law, and which were designated as the *international ohm*, the *international ampere*, and the *international volt*, respectively. These numerical values are given in the following definitions:

DEFINITIONS BY THE CHICAGO CONGRESS.

The *international ohm*, "which is based upon the ohm equal to 10^9 units of resistance of the cgs system of electromagnetic units, is represented by the resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice, 14.4521 grams in mass, of a constant cross-sectional area and of the length of 106.3 cm."

The *international ampere* "is one-tenth of the unit of current of the cgs system of electromagnetic units, and is represented sufficiently well for practical use by the unvarying current, which, when passed through a solution of nitrate of silver in water and in accordance with the accompanying specifications, deposits silver at the rate of 0.001118 of a gram per second."

The *international volt* "is the electromotive force that, steadily applied to a conductor whose resistance is one international ohm, will produce a current of one international ampere, and which is represented sufficiently well for practical use by $\frac{1000}{1434}$ of the electromotive force between the poles of the voltaic cell, known as Clark's cell, at a temperature of 15° C" . . .

It will be noticed that the method of fixing the values of these three fundamental quantities is not uniform. The international ohm is based upon but is not said to be equal to 10^9 cgs units of resistance. It is, however, represented by the resistance of a column of mercury of definite length and mass. The international ampere, on the contrary, *is* one-tenth of the unit of current of the cgs system of electromagnetic units, and is represented *sufficiently well for practical use* by the current which deposits a certain mass of silver per second under specified circumstances. The international volt is the electromotive force which will cause an ampere to flow through an ohm, and is represented *sufficiently well for practical use* by a certain fractional part of the unit of a Clark cell. Thus the international ohm is fixed by the resistance of a mercury column, the international ampere by taking one-tenth of a cgs unit of current, and the international volt by means of the ohm and ampere. The figures for the mass of silver deposited per second by an ampere and the value of the volt in terms of a Clark cell were meant to be the equivalent of these values, as nearly as they were known at the time.

LEGISLATION IN VARIOUS COUNTRIES.

Not all the countries represented in the Chicago congress legislated on the subject of electrical units, and of those which did no two adopted precisely the same definitions. The United States was the first to legislate, and by an act of Congress, approved July 12, 1894, definitions were adopted substantially equivalent to those adopted at Chicago. Congress authorized the National Academy of Sciences to prepare and publish detailed specifications for realizing the international ampere and the international volt by means of the silver voltameter and the Clark standard cell. Accordingly such official specifications were adopted and published by the academy on February 9, 1895.

Similar definitions were adopted by Canada July 23, 1894, by Great Britain August 23, 1894, and by France April 25, 1896. Germany did not act until June 1, 1898, and then adopted definitions which differed in two important respects. First, the ampere was not stated to be one-tenth the cgs unit of current, but to be represented by the current which deposits 0.001118 gram of silver per second in a silver voltameter. Thus the ampere was defined in the same manner as the ohm. Second, the volt was defined as the electromotive force which caused an ampere to flow through an ohm, and its value in terms of a standard cell was not stated in the law. In 1900 Austria adopted definitions of the electrical units, in which the ampere was defined as by America, Great Britain, France, and Canada, but the definition of the volt was like that of Germany.

In the five years that intervened between the Chicago congress and the adoption by Germany of legal definitions for the electrical units it was shown by new experiments that the value assigned to the emf of the Clark cell was probably nearly a tenth of one per cent too large. Accordingly, a smaller and more nearly correct value was chosen by Germany, namely, 1.4328 instead of 1.434 volts, at 15°.

In the definitions adopted by the Chicago congress and in all the legal definitions adopted in the various countries the ohm and the ampere were the two units defined independently, the volt being defined in terms of the ohm and ampere. In the United States, France, and Canada the volt was also defined in terms of the emf of the Clark cell, qualified, however, in each case by the phrase "is practically equivalent to" (U. S.) or "is represented sufficiently well for practical use by" (France and Canada). In the Order in Council of August 23, 1894, which established the legal definitions of the electrical units for Great Britain, however, the double definition of the volt is given without such qualifying phrase.

DIVERGENCES IN THE DEFINITIONS OF THE UNITS.

In all countries, therefore, except Germany, the first definition of the ampere is that it is one-tenth of the cgs unit in the electromagnetic system, the value of which is determined by measurements with an absolute current balance or electrodynamometer. Precision measurements with such instruments are very difficult, and until recently have not been made with sufficient accuracy to fix with certainty the fourth decimal figure in the value of the standard cell. The second definition of the ampere, in terms of the mass of silver deposited per second in a silver voltameter, has not been employed in practice to any extent for the reason that different observers obtained different quantities of silver, according to the details of the method followed in carrying out the work. A voltameter in which filter paper was employed almost invariably gave an appreciably heavier deposit than one using a porous cup between the anode and cathode, and yet no satisfactory reason could be given for such excess of weight of the silver deposited. Whether the deposit was too heavy with the filter paper or too light without it was not definitely known; recent investigations at the Bureau of Standards, however, have shown that the filter paper causes chemical changes in the electrolyte which give rise to an excessive deposit of silver. The official specifications of most countries required the use of filter paper.

PASSING FROM THE CLARK TO THE WESTON CELL.

Because of the impracticability of fixing the ampere from time to time by absolute measurements, and because the silver voltameter was not as satisfactory or reliable as it was expected to be, the practice in all countries (including Germany, where the value of the Clark cell was not stated in the law) has been to fix the volt by reference to standard cells, and also, because of its great convenience, to measure current in terms of standard resistances and standards of electromotive force. In most countries the electromotive force of the Clark cell was taken as 1.434 at 15°, but in Germany and some other countries it was taken as 1.4328 volts. However, standard cells were not as reliable ten years ago as they are at the present time. An enormous amount of work has been done since the Chicago Congress, particularly in recent years, at the national standardizing institutions of England, Germany, France, and America. This work has shown that the Weston cell possesses some advantages over the Clark cell, and at the London International Electrical Congress of 1908 the Weston cell was officially adopted in place of the Clark cell as the standard of electromotive force. In the improvement of the Clark and Weston cells, which took place in the course of the fifteen years between the Chicago and London congresses, largely through the improved methods of preparing the mercurous sulphate, the electromotive force of both cells changed slightly. At the Bureau of Standards an attempt was made to maintain the volt as nearly constant as possible, and the newer cells therefore had to be given a slightly different value from the old ones. Hence arose a slight discrepancy between the values employed in the United States and in Great Britain and some other countries, though not as great as the difference between Germany and Austria on the one hand and America, Great Britain, and France, etc., on the other. These differences were not large enough to be important from a commercial point of view, but they were appreciable in precision measurements, and were more or less embarrassing when certain kinds of electrical instruments made in one country were used in another. Even in the comparison of photometric standards between the national laboratories of Germany, England, France, and America careful allowance had to be made for the differences in the volt, and hence of the ampere in the three countries, in order to insure the same current passing through the standard lamps when measured in the several countries.

An international electrical conference was held in connection with the St. Louis Exposition in 1904, at which the desirability of securing international uniformity in electrical units and standards was emphasized. A preliminary conference, called by the Physikalisch-Technische Reichsanstalt for the purpose of discussing the matters to be brought before a subsequent electrical congress, was held in Berlin in October, 1905, and, in accordance with an understanding reached at Berlin, a formal international conference, called by Great Britain, was held in London in 1908. At this latter conference new definitions were adopted, in which a distinction was made between the *ohm* and the *international ohm*, and so for the other units. That is, the *ohm* is 10^9 cgs units of resistance, whereas the *international ohm* is the resistance of a specified column of mercury. Following are the definitions, adopted by the London Conference, of the four fundamental electrical units.

DEFINITIONS OF THE FUNDAMENTAL ELECTRICAL UNITS BY THE LONDON CONFERENCE.

These fundamental units are:

1. The **Ohm,** the unit of electric resistance, which has the value of 1 000 000 000 (10^9) in terms of the centimeter and the second;

2. The **Ampere,** the unit of electric current, which has the value of one-tenth (0.1) in terms of the centimeter, gram, and second;

3. The **Volt,** the unit of electromotive force, which has the value of 100 000 000 (10^8) in terms of the centimeter, gram, and second;

4. The **Watt,** the unit of power, which has the value 10 000 000 (10^7) in terms of the centimeter, the gram, and the second.

As a system of units representing the above and sufficiently near for the purpose of electrical measurements, and as a basis for legislation, the conference recommended the adoption of the international ohm, the international ampere, the international volt, and the international watt, defined as follows:

1. The *International Ohm* is the resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice, 14.4521 grams in mass, of a constant cross-sectional area and of a length of 106.300 centimeters.

2. The *International Ampere* is the unvarying electric current which, when passed through a solution of nitrate of silver in water, deposits silver at the rate of 0.00111800 of a gram per second.

3. The *International Volt* is the electrical pressure which, when steadily applied to a conductor the resistance of which is one international ohm will produce a current of one international ampere.

4. The *International Watt* is the energy expended per second by an unvarying electric current of one international ampere under an electric pressure of one international volt.

The details of the procedure for realizing the international ohm from the resistance of the specified column of mercury and of realizing the international ampere from the silver voltameter were given in accompanying specifications, except that the specifications for the silver voltameter formulated at the London Conference were very inadequate. The reason for this was that the experience of those who had done most work in recent years with the silver voltameter was so diverse that agreement could not be reached as to the best procedure. It was illogical to specify the precise amount of silver deposited by an ampere before the specifications were agreed upon, as it was possible that when the voltameter was better understood and the best procedure was determined that the number chosen would be found not to be as nearly correct as is desirable. But a majority of the delegates felt that the change would be slight at the most and preferred to specify the round number (0.00111800 gram per second) that had been previously used rather than some odd figure that might be more exact.

Having chosen the old figures to express the value of the international ohm and the international ampere, it remained to fix the specifications of the Weston normal cell and to adopt a value for the electromotive force in terms of the international volt, so that it should be consistent with the values of the two primary units. Data at hand did not enable the conference to fix this value with certainty to within one part in 10 000, and hence it adopted as provisional only the number 1.0184 international volts as the value of the electromotive force at 20° C of the Weston normal cell.

THE INTERNATIONAL COMMITTEE ON ELECTRICAL UNITS AND STANDARDS.

In order that the specifications of the silver voltameter might be completed as speedily as possible and a more accurate value determined for the Weston normal cell, the conference appointed an International Committee on Electrical Units and Standards which was authorized to take up this work and also to complete the work of the conference in any other particulars that seemed necessary. It was also authorized to encourage cooperative investigations among the several national standardizing institutions, and to secure frequent comparisons of the electrical standards of different countries in order to insure international uniformity in electrical measurements. This committee represents eleven different countries, there being two members each from America, England, France, and Germany, and one member each from Austria, Italy, Russia, Switzerland, Holland, Belgium, and Japan. The president of the committee is Prof. Dr. E. Warburg, president of the Physikalisch-Technische Reichsanstalt, Berlin; vice-president, Dr. R. T. Glazebrook, director of the National Physical Laboratory, London; treasurer, Prof. S. W. Stratton, director of the Bureau of Standards, Washington; secretary, Prof. E. B. Rosa, chief physicist of the Bureau of Standards, Washington. The other eleven members of the committee are as follows: Dr. Osuke Asano, Department of Communications, Tokyo, Japan; M. René Benoît, Bureau International, Sèvres, France; Dr. N. Egoroff, director, General Chamber of Weights and Measures, St. Petersburg, Russia; Prof. Eric Gérard, Liège, Belgium; Prof. H. Haga, Groningen, Holland; Dr. Ludwig Kusminsky, Commission of Weights and Measures, Vienna, Austria-Hungary; Dr. Stephen Lindeck, Physikalisch-Technische Reichsanstalt, Berlin, Germany; Prof. Gabriel Lippmann, The Sorbonne, Paris; Prof. Antonio Ròiti, Florence, Italy; Mr. A. P. Trotter, Electrical Standards Laboratory, Whitehall, London; Prof. H. F. Weber, Zürich, Switzerland.

In addition to the fifteen members appointed by the International Electrical Conference, the committee was authorized to elect associate members to assist in carrying on its work, and at its first meeting in London, following the conference, five associate members were elected as follows: Prof. W. Jaeger, of Berlin; Mr. F. E. Smith, of London; Prof. Paul Janet, of Paris; Prof. H. S. Carhart, of Ann Arbor, Mich., and Dr. F. A. Wolff, of the Bureau of Standards, Washington.

AN INTERNATIONAL INVESTIGATION.

It was impossible to select a new value of the Weston normal cell in terms of the ohm and the ampere until the latter should be more precisely defined than had been done by the London Conference. Correspondence among the members of the committee who were connected with national standardizing institutions seemed to indicate that it would be impossible to agree upon the specifications of the silver voltameter without further investigation. It was therefore proposed that a joint investigation to clear up, as far as possible, outstanding problems on the standard cell and the silver voltameter be arranged with representatives of several of the national standardizing laboratories as participants, and the Bureau of Standards offered its laboratory facilities for the proposed investigation. As there were no funds available to pay the personal expenses of the delegates, the treasurer of the International Committee on Electrical Units and Standards undertook to secure the funds. In this connection he received valuable assistance from Mr. John W. Lieb, jr., who placed the matter before the governing bodies of the American Institute of Electrical Engineers, the National Electric Light Association, the Association of Edison Illuminating Companies, and the Illuminating Engineering Society. These four societies generously made appropriations of $500 each to defray the personal expenses of the three European delegates.

It was arranged that the proposed investigation should be carried out at the Bureau of Standards by representatives of that institution, together with one delegate from the Physikalisch-Technische Reichsanstalt, Berlin, one from the National Physical Laboratory, London, and one from the Laboratoire Central d'Electricité, Paris. The European delegates as appointed by the directors of the three above-named institutions, were Prof. W. Jaeger, Prof. F. E. Smith, and Prof. F. Laporte. The representatives of the Bureau of Standards were Dr. E. B. Rosa and Dr. F. A. Wolff.

In addition to the work on standard cells and the silver voltameter, a comparison was made of the resistance standards of the several national standardizing institutions which showed a very close agreement.

THE NEW VALUE OF THE WESTON NORMAL CELL.

The first result of this international cooperative investigation was to show that the electromotive force of the Weston normal cell derived from the international ohm and the international ampere according to the resolutions of the London Conference is, within one part in 10 000,

$$E = 1.01830 \text{ international volts at } 20^\circ \text{ C.}$$

The members of the special technical committee unanimously recommended that this value [1] be adopted, without waiting for all the details of the official specifications to be worked out, inasmuch as experiments showed that the effect of any outstanding differences as to procedure probably could not change the mass of silver deposited enough to affect the last

[1] The number was written 1.0183, suppressing the zero in the fifth decimal place. In the numerical values of the ohm and ampere, adopted at London, the numbers were written 106.300 and 0.00111800, the two zeros in each case being added to avoid any ambiguity; that is, to show that the numbers are assumed exact and not simply approximate. In the value of the electromotive force of the Weston cell it was first ascertained by experiment that the number consistent with the formal definition was (within one part in 10000) 1.0183 international volts. It was then agreed to use this round value as the *exact value* of the Weston normal cell at 20° C. Hence since this is to be the exact value for the present at least, and since we must use five decimal places to express the values of all cells differing by one or more parts in a hundred thousand, it seems better to use consistently five decimal places in the formal definitions.

figure in the above number. Accordingly a proposal was submitted to all the members of the International Committee that the various governments represented on the committee be asked to adopt officially this new value for the Weston normal cell on January 1, 1911. The vote on this proposal having been favorable, the Bureau of Standards will adopt the new value on that date.

The formula for the temperature coefficient of the Weston normal cell adopted by the London Conference, based on the investigations of the Bureau of Standards, is as follows:

$$E_t = E_{20} - 0.0000406\ (t-20°) - 0.00000095\ (t-20)^2 + 0.000000001\ (t-20)^3$$

VALUES HERETOFORE IN USE.

The following values for the Weston normal cell have been in use up to the present time in the various countries:

In the United States	1.0189	international volts at	25°
equivalent to	1.019126	" " "	20°
In Germany	1.0186	" " "	20°
In Great Britain [2]	1.0184	" " "	20°

As a consequence of the different values used for the Weston cell, both the volt and the ampere as used in the various countries have been slightly different, for precise measurements of electric current have nearly always been by means of standard resistances and standard cells. The watt has differed twice as much as the volt or ampere.[3] Under the new arrangement these units will be precisely the same in the different countries.

THE MAINTENANCE OF THE NEW VALUE.

The Weston normal cell has been steadily improved until now its value as set up by different observers, following the same specifications, is uniform to within a few thousandths of 1 per cent. The mean values of the standard cells of the national laboratories of Great Britain, Germany, France, and the United States when compared at various times in recent years have agreed to within a few parts in 100 000. Cells set up from time to time in the laboratories of the Bureau of Standards according to standard specifications attain a uniform value within a month to within one part in 100 000 on the average, and although the values decrease slightly with age this decrease

[2] Great Britain used a value slightly larger than that in the United States until January 1, 1909, when the provisional value (1.0184) adopted by the London Conference was adopted provisionally by the National Physical Laboratory.

[3] As an illustration of the practical importance of small differences in electrical units, the following incident which occurred recently is of interest, Some precision alternating-current wattmeters were ordered from a German manufacturer by an American customer, and their accuracy was guaranteed. The manufacturer neglected to take account of the small difference between the "international volt" of America and the "international volt" of Germany. One of the instruments on test showed a slightly greater error than allowed in the contract and was rejected. If the volt had been the same in the two countries, the instrument would have been within the guaranteed precision.

does not exceed one in 100 000 during the first year thereafter. The value of the international volt may therefore be derived to within 2 parts in 100 000 from cells set up according to standard specifications, which cells are not less than one month nor more than one year old. While the value of the standard cell is derived from the standards of resistance and the silver voltameter, and is supposed to be checked in the same way from time to time, we know that Weston normal cells are so uniform and so reliable that they will require such checks very infrequently indeed, and the probability is that the uncertainty of the silver voltameter is greater than that of the cells. We may therefore expect that the mean value of the international volt as maintained by the joint efforts of several national laboratories will be constant in future to within one or two parts in a hundred thousand, although its absolute value is known with certainty only to the fourth decimal place.[4] There is no likelihood of another change being necessary in the international volt, or of any change being necessary in the international ohm. As the precision of absolute measurements increases we may find with high accuracy the numerical value of the difference between the volt and the international volt, and between the ohm and the international ohm, etc., and such differences would be applied as corrections to convert voltage, current, or power in international units to absolute measure, but there should be no necessity for making further changes in the values of the international units. For the first time we have a basis for securing international uniformity both in the definitions and in the specifications, and also means for keeping the standard of the different countries in agreement.

RESULTS OF THE CHANGE IN THE VOLT.

Weston portable unsaturated cells, as supplied by the Weston Electrical Instrument Company, as well as the saturated Weston normal cells, will require a correction of 8 units in the fourth decimal place (or 85 in the fifth decimal place) to reduce to the new basis. Thus a cell having an electromotive force of 1.0192 becomes 1.01835 on the new basis. Since a given voltage is expressed by a smaller number, *the new unit is larger than the old.* In the same way a current expressed as 1.0000 ampere on the old basis is 0.9992 ampere on the new. The watt is altered twice as much as the ampere and volt; that is, 0.16 per cent, 50 watts on the old basis being 49.92 watts on the new. A 16-candlepower lamp burning at 3.05 watts per candle on the old basis takes 48.80 watts. On the new basis the same current will be rated as furnishing 48.72 watts, and the lamp taking therefore 3.045 watts per candle. The difference here is of course insignificant.

A lamp giving 16 candles at 110.0 volts will on the new basis of voltage measurement give 16 candles at 109.9 volts (or 109.91 volts more exactly).

[4] The number 1.01830 international volts is the value to be assigned to the mean of the groups of standard cells maintained by several national standardizing laboratories. If the mean of those belonging to any particular country is less than the mean of all by one part in 100000 the value for that group mean will be 1.01829, whereas the various cells of the group may vary perhaps between 1.01828 and 1.01830.

If, however, the voltage be made 110.0 on the new basis the slight increase of current will make the lamp give about 16.08 candles.

Potentiometers like the standard five-dial form of Leeds & Northrup, in which the resistance in the standard cell circuit is adjusted to a particular value of the standard cell, will require a slight change in the resistance to adapt them to measure potential differences with the new value of the standard cell. Potentiometers in which the dials are reset to the value of the electromotive force of the standard cell when balancing on the cell will of course require no change. One style of volt box will for the same reason require a change. Potentiometers with a dial adapting them to cells ranging from 1.0190 to 1.0200 volts may easily be changed so as to suit cells ranging from 1.0180 to 1.0190 volts.

Weston portable cells are similar in construction to the Weston normal cells as officially defined, except that instead of having cadmium sulphate crystals present in excess, the solution of cadmium sulphate is saturated at approximately 4° C and hence is unsaturated at all higher temperatures. This cell has a much smaller temperature coefficient than the saturated cell, and for most electrical measurements the change with temperature may be neglected. The nearly zero temperature coefficient results from the fact that the temperature coefficient of each leg of the cell is nearly equal and of opposite sign, whereas in the saturated cell the temperature coefficients of the two legs do not so nearly balance each other. If the temperature of the two legs of the cell is not the same, there will of course be a change in the electromotive force of the unsaturated cell. The unsaturated cells are not so nearly uniform in electromotive force as the saturated cells. Thus of 145 unsaturated Weston cells tested by the bureau in seven years (38 were retests of cells previously tested) the values of the electromotive force have been as follows:

For	3	cells	E = 1.0190	volts
	2	"	= 1.0191	"
	7	"	= 1.0192	"
	8	"	= 1.0193	"
	25	"	= 1.0194	"
	24	"	= 1.0195	"
	33	"	= 1.0196	"
	25	"	= 1.0197	"
	13	"	= 1.0198	"
	5	"	= 1.0199	"
Total	145	"	Mean = 1.0195_4	"

On the new basis this is 1.0186_9 "

The electromotive force of these cells generally decreases slightly with age. To illustrate, the Bureau of Standards has 15 of these cells in use in its laboratories which have on the average decreased only one ten-thousandth of a volt in the last four years, the change in the various cells being from nothing to three ten-thousandths of a volt. The mean electromotive force of the 15 cells, which are from 5 to 8 years old, is 1.0192 volts, the range being from 1.0190 to 1.0195 volts.

The same cells have been sold by the German Weston Company for many years under the name "Weston Normal Elemente." This is, however, not what is now known officially as the Weston normal cell, which is the saturated cell.

For a time after January 1, 1911, certificates issued by the Bureau of Standards for tests affected by this change will state the values in the new unit and give also as a supplemental statement the value in the old unit.

Congress will be asked to repeal the act of July 12, 1894, and to redefine the fundamental electrical units in accordance with the resolutions of the London Conference. In the meantime, however, the Bureau is free to adopt the new value of the Weston normal cell, for in so doing it is not violating the present law. This law defines the volt as the electromotive force which will cause an ampere to flow through an ohm, and then gives the approximate value in terms of the electromotive force of a Clark cell as made in 1893. In adopting the new value of the Weston normal cell we are conforming as closely as possible to the present legal definition of the volt, necessarily ignoring the old approximate value of a cell now superseded as a standard.

S. W. Stratton,
Director.

Approved:

Benj. S. Cable,
Acting Secretary.

O