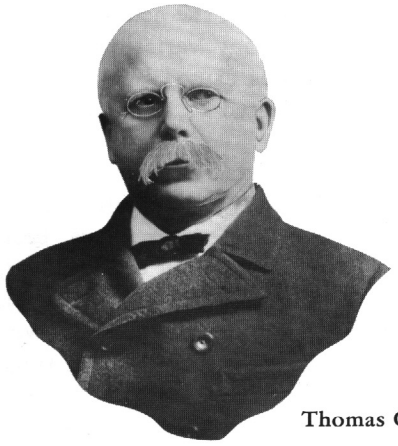
the first General Conference on Weights and Measures was held in Paris, and this work was approved at this meeting.

The meter and kilogram that agreed most closely with the meter and kilogram of the Archives were declared to be the international meter and the international kilogram. These two standards, with certain other meters and kilograms, were deposited in a subterranean vault under one of the buildings of the International Bureau, where they are only accessible when three independent officials with different keys are present. The other standards were distributed by lot to the various governments contributing to the support of the International Bureau. Those falling to the United States were meters Nos. 21 and 27 and kilograms Nos. 4 and 20.

Meter No. 27 and kilogram No. 20 were brought under seal to this country by George Davidson, of the Coast and Geodetic Survey. On January 2, 1890, the packing cases containing these standards were opened at the White House and the standards were accepted by President Harrison, who certified that they were received in good condition and that he confidently believed that they were the standards referred to in the reports. These reports, relating to the standards in question, had been submitted by B. A. Gould, United States delegate to the International Conference on Weights and Measures, and by Davidson. The other two standards were received the following July and were deposited in the Office of Weights and Measures, where those accepted as national standards by the President had already been taken.[17]

7. The Mendenhall Order



Thomas Corwin Mendenhall, 1841–1924.

On April 5, 1893, T. C. Mendenhall, then Superintendent of Weights and Measures, with the approval of the Secretary of the Treasury, decided that the international meter and kilogram would in the future be regarded as the fundamental standards of length and mass in the United States, both for metric and customary weights and measures. This decision, which has come to be known as the "Mendenhall Order," was first published as Bulletin No. 26 of the Coast and Geodetic Survey, approved for publication April 5, 1893, under the title, "Fundamental Standards of Length and Mass"; it was republished in 1894 under the same title, as appendix No. 6—Report for 1893 of the Coast and Geodetic Survey, "to give it a more permanent form." In appendix No. 6 there was included as an addendum to the text of Bulletin No. 26 a section headed "Tables for Converting Customary and Metric Weights and Measures," comprising some text, five customary-to-metric conversion tables, and five metric-to-customary conversion tables.

As a matter of interest and record, the full text of appendix No. 6 of the Report for 1893 of the Coast and Geodetic Survey, with the exception of an editorial footnote and the ten conversion tables, is reproduced as appendix 3 of this publication.

The Mendenhall Order initiated a departure from the previous policy of attempting to maintain our standards of length and mass to be identical with those of Great Britain, and thereafter there was a small difference between the British and the United States yards, a difference which may have been negligible in 1893 but which became of real importance as the British Imperial Yard bar gradually changed in length and as the requirements for greater accuracy in measurements increased.

As has been seen, when the United States yard was first adopted upon Hassler's recommendation in 1832, it was defined as a particular interval on the Troughton bar, through which it was related to the British yard standard. The intention was to fix the United States yard as equal to the British yard.

When the "Imperial" system of weights and measures was established by the British in 1824, the Imperial Yard was defined in terms of a specific yard standard and a particular bar was legalized as the Imperial standard. In 1834, that bar was so damaged in the burning of the Houses of Parliament that replacement was necessary; a new bar was constructed, and in 1855 this bar was legalized as the new Imperial Standard Yard. In the course of the years this bar proved to be insufficiently stable in length and was found to be shortening by measurable amounts.

[17] Upon the establishment of the Bureau of Standards on July 1, 1901, all standards and other property in possession of the Office of Weights and Measures passed under the control of the Bureau.

For a time, efforts were made by United States authorities to maintain equivalence between the United States and British yards. Such efforts were abandoned, however, in 1893, when the Mendenhall Order (see appendix 3, p. 26) defined the United States yard in terms of the International Prototype Meter.

The difference between the United States and the British yards, prior to the 1959 actions of both governments in recognizing the new International Yard (see appendix 5, p. 28), reached a maximum value in the order of 0.000 13 inch, the United States yard being the longer.

The case of the pound was slightly different as will be seen from the record of the values assigned to it with respect to the kilogram.

The United States law of 1866 that made the use of the metric system permissive, carries the relation, 1 kilogram=2.2046 avoirdupois pounds, an equation now believed to have been intended as sufficiently accurate for commercial purposes but not as a precise definition of the relationship between basic units. This value resulted from a rounding off of the results of an 1844 comparison made in England between the British pound and the Kilogram of the Archives which gave the relation, 1 pound=0.453 592 65 kilogram; this relation was used in Great Britain and in the United States for years. Expressed reciprocally, this relation becomes, approximately, 1 kilogram= 2.204 621 61 pounds.

In the Coast and Geodetic Survey Report for 1893 that contained the Mendenhall Order, (see appendix 3, p. 26), the kilogram-avoirdupois pound relationships are variously stated as follows:

1 pound avoirdupois	$=\frac{1}{2.2046}$ kg
1 pound avoirdupois	$=\frac{1}{2.20462}$ kg
2.204 622 34 pounds avoirdupois	=1 kilogramme
1 avoirdupois pound	=453.592 427 7 grammes

A comparison made in 1883 between the British Imperial Standard Pound and the International Prototype Kilogram resulted in the relation 1 Imperial Pound=0.453 592 427 7 Kilogram; this relation was accepted in both Great Britain and the United States, but uniformity between the two countries ended in 1889 when Great Britain officially adopted a rounded-off value, making the relation, 1 Imperial Pound= 0.453 592 43 Kilogram. From its founding in 1901 until July 1, 1959, the National Bureau of Standards recognized and used the relation 1 pound avoirdupois=0.453 592 427 7 kilogram.

This uncertainty as to the precise values of the units of length and mass in common use, the yard and the pound respectively, was caused by inadequacies of the standards representing them. The bronze yard No. 11, which was an exact copy of the British imperial yard both in form and material, had shown changes when compared with the imperial yard in 1876 and 1888 which could not reasonably be said to be entirely due to changes in No. 11. Suspicion as to the constancy of the length of the British standard was therefore aroused. Neither the troy pound of the mint nor the copies of the imperial yard in the possession of the Office of Weights and Measures were satisfactory standards. The mint pound is made in two pieces, the knob being screwed into the body; hence its density can not be determined by weighing in water on account of danger of leakage. Moreover, it is made of brass not plated, and therefore liable to alteration by oxidation.

On the other hand, the new meters and kilograms represented the most advanced ideas of standards, and it therefore seemed that greater stability in our weights and measures as well as higher accuracy would be secured by accepting the international meter and kilogram as fundamental standards.

Time proved the wisdom of this action, and therefore when the National Bureau of Standards was established in July 1901, it fully accepted the decision made by the Office of Weights and Measures in 1893 to adopt the meter and kilogram as fundamental standards.

The National Bureau of Standards was established in response to the requests of scientists, technologists, and industrialists that a governmental agency be founded to develop standards, carry out researches basic to standards, and calibrate standards and devices. The Office of Weights and Measures had carried out some of this work in its limited field, and the increasing use of electricity was making the need of a central standardizing authority rather critical. Similar needs were also felt in other fields of science and industry.

Institutions of the type envisioned had already been formed in Great Britain and Germany and the Office of Weights and Measures was deemed to be a suitable nucleus on which to build in this country. Fortunately, Congress was favorably impressed with the idea and on March 3, 1901 it passed an act providing that "The Office of Standard Weights and Measures shall hereafter be known as the National Bureau of Standards" and setting forth the functions of the new Bureau. These functions were considerably expanded in an amendment passed in 1950.

Executive Mansion.

Be it known: That on this second day of January A. D. one thousand eight hundred and ninety in the City of Washington there were exhibited before me, Benjamin Harrison, President of the United States, by T.C. Mendenhall, Superintendent of the United States Coast and Geodetic Survey two packing boxes described as follows:

One box bearing the stencil number 27 and sealed twice with red wax bearing the impress of a crest over the Gothic letter G.

One small hinged box bearing the stencil number 20 and the letter A and sealed twice with red wax bearing the impress of a crest over the Gothic letter G as before described, and with two black seals with the Gothic letters W.H.

That the impression of the red wax seals aforesaid was recognized as that of the private seal of Dr. Benjamin Apthorp Gould, United States Delegate to the International Conference on Weights and Measures convened at Paris September 24th 1889, that there was also exhibited a report by said B.A. Gould to the Secretary of State reciting that he received and accepted on behalf of the United States a prototype Metre numbered 27 together with another one numbered 21 metre bar of the alloy of 1874 numbered 12, together with two prototype Kilogrammes, one numbered 4, and one numbered 20 with their accessories, excepting thermometers; and that he enclosed said prototype Metre No. 27 and said prototype Kilogramme No. 20 with its accessories in their inner cases and these in their turn in boxes marked and thereafter sealed by him as above described and that said boxes were delivered by him to Mr. Whitelaw Reid, United States Minister at Paris, and there was also exhibited a report by George Davidson, Assistant United States Coast and Geodetic Survey, affirming that these boxes were received by him from the United States Minister at Paris on October 27th 1889 as being the boxes supposed to contain the National Prototype Metre No. 27, and the National Propotype Kilogramme No. 20 with its accessories.

That the Superintendent of the Coast and Geodetic Survey did affirm that these boxes were received by him from the said George Davidson on the 27th day of November 1889 at the Office of the Coast and Geodetic Survey in Washington, D.C. and that they have remained in his possession, sealed and with their contents undisturbed in every particular from the date of their delivery aforesaid until thus exhibited.

That the aforesaid boxes being thereupon opened in my presence were found to contain the inner cases as described in the aforementioned report of Dr. B.A. Gould and these inner cases being opened were found to contain a Metre bar numbered 27 and a Kilogramme weight No. 20 in good preservation and apparently in every particular in the same state as when first enclosed therein, and which I therefore confidently believe to be the identical Standards referred to in the aforesaid reports.

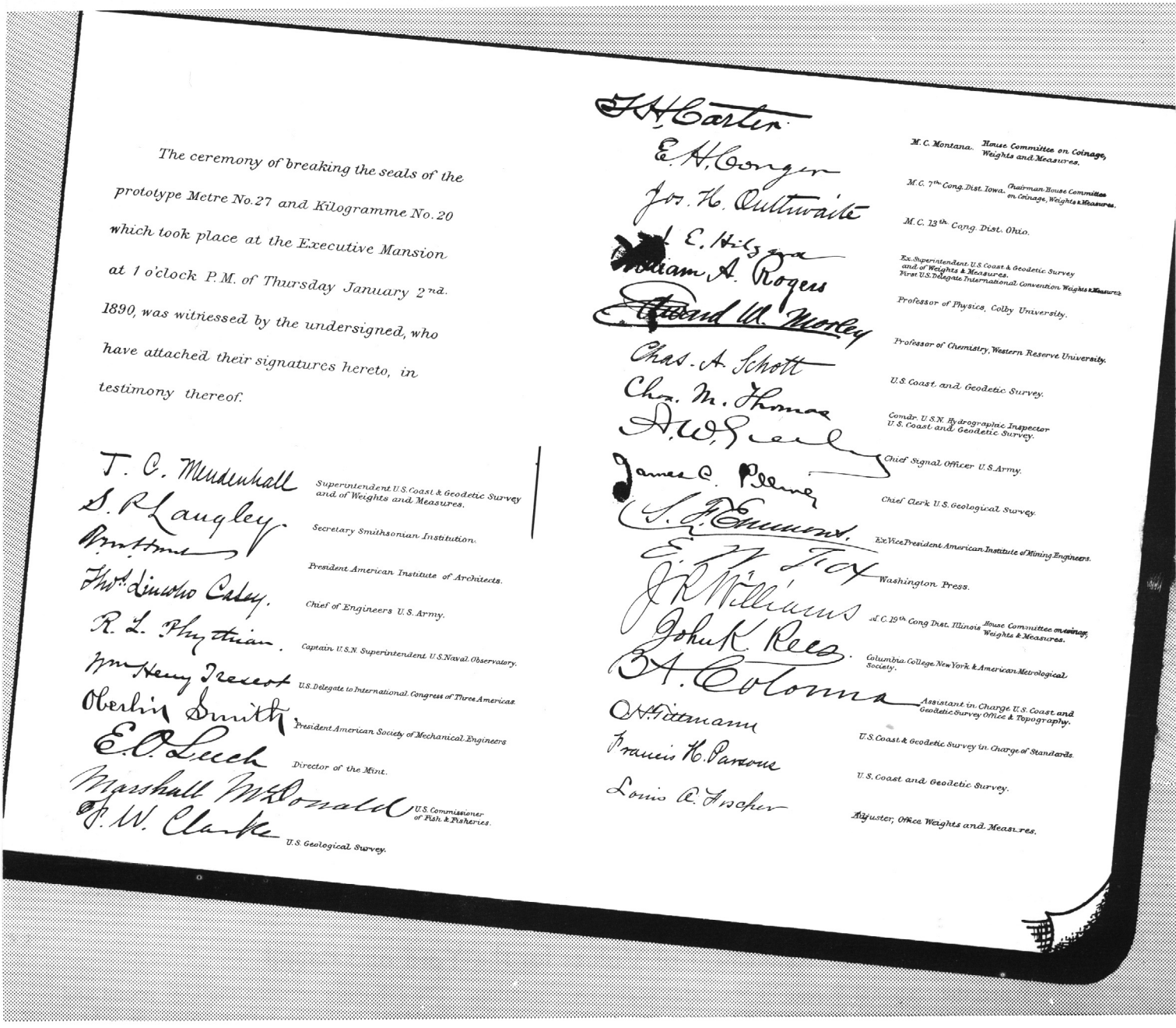
Benj Harrison

By the President

James G. Blaine
Secretary of State

January 2/1890 -

William Windom
Secretary of the Treasury.



The ceremony of breaking the seals of the prototype Metre No. 27 and Kilogramme No. 20 which took place at the Executive Mansion at 1 o'clock P.M. of Thursday January 2nd. 1890, was witnessed by the undersigned, who have attached their signatures hereto, in testimony thereof.

T. C. Mendenhall — Superintendent U.S. Coast & Geodetic Survey and of Weights and Measures.
S. P. Langley — Secretary Smithsonian Institution.
[illegible] — President American Institute of Architects.
Thos. Lincoln Casey — Chief of Engineers U.S. Army.
R. L. Phythian — Captain U.S.N. Superintendent U.S. Naval Observatory.
Wm. Henry Trescot — U.S. Delegate to International Congress of Three Americas.
Oberlin Smith — President American Society of Mechanical Engineers
E. O. Leech — Director of the Mint.
Marshall McDonald — U.S. Commissioner of Fish & Fisheries.
T. W. Clarke — U.S. Geological Survey.

H. H. Carter — M. C. Montana. House Committee on Coinage, Weights and Measures.
E. H. Conger — M. C. 7th Cong. Dist. Iowa. Chairman House Committee on Coinage, Weights & Measures.
Jos. H. Outhwaite — M. C. 13th Cong. Dist. Ohio.
E. H. Hilgard — Ex. Superintendent U.S. Coast & Geodetic Survey and of Weights & Measures. First U.S. Delegate International Convention Weights & Measures.
William A. Rogers — Professor of Physics, Colby University.
Edward W. Morley — Professor of Chemistry, Western Reserve University.
Chas. A. Schott — U.S. Coast and Geodetic Survey.
Chas. M. Thomas — Comdr. U.S.N. Hydrographic Inspector U.S. Coast and Geodetic Survey.
A. W. Greely — Chief Signal Officer U.S. Army.
James C. Pilling — Chief Clerk U.S. Geological Survey.
C. S. Fremont — Ex Vice President American Institute of Mining Engineers.
E. F. Fick — Washington Press.
J. R. Williams — M. C. 19th Cong Dist. Illinois House Committee on Coinage, Weights & Measures.
John K. Rees — Columbia College New York & American Metrological Society.
A. Colonna — Assistant in Charge U.S. Coast and Geodetic Survey Office & Topography.
O. H. Tittmann — U.S. Coast & Geodetic Survey in Charge of Standards.
Francis H. Parsons — U.S. Coast and Geodetic Survey.
Louis A. Fischer — Adjuster, Office Weights and Measures.

Certificate in relation to the receipt of the national prototype metric standards of length and mass.

The original of this certificate is preserved in the standards vault of the National Bureau of Standards.

Certificate in relation to the ceremony of breaking the seals of Meter No. 27 and Kilogram No. 20.

The original of this certificate is preserved in the standards vault of the National Bureau of Standards. It will be observed that the last signature on this certificate is that of Louis A. Fischer, who signed as Adjuster, Office of Weights and Measures.

in expanding the work in weights and measures into a national standards bureau, the work in the field of weights and measures had more opportunities for growth. Mr. Louis A. Fischer, Chief of the Division of Weights and Measures from the organization of the National Bureau of Standards in 1901 until his death in 1921, probably was the first man in the United States to undertake the promotion of weights and measures supervision on a national basis. In 1902, Mr. Fischer directed scattered inspections of weighing and measuring devices and transactions involving quantities in several of the larger cities in the State of New York. The purpose of these visits was to determine what amount of protection the buying public was receiving against short weight and short measure in purchases. As a result of this investigation, as well as the increasing number of complaints being received in Washington, staff members of the National Bureau of Standards decided in 1904 to call a meeting of weights and measures officials and other officers of the State governments to discuss ways and means of affording to the public adequate supervision over weights and measures in everyday transactions.

This meeting was held in Washington in 1905, and, although invitations went to all States, the meeting was attended by only eleven persons, representing eight States, the District of Columbia, and the National Bureau of Standards. As it turned out, this was the first National Conference on Weights and Measures, and was the inauguration of meetings that have been held annually with exceptions due to war or other national emergency. Interest, attendance, and participation in the Conferences, as well as the influence of the Conference, have increased steadily. The registered attendance at the 47th meeting, held in Washington during June 1962, was 420. Out of the National Conference on Weights and Measures has come the basis for uniformity of weights and measures law and enforcement activities.

The delegates to the first Conference and to all subsequent meetings have had as their principal aim the application of uniform and satisfactory standards of measurement to everyday commercial transactions.

The need for uniformity of State weights and measures legislation was one of the principal reasons for the first national meeting of weights and measures officials and was considered at that time. As the result of a resolution of the second meeting, a Model State Law on Weights and Measures was composed. In the year 1911, after detailed and extensive discussions, the Sixth National Conference adopted, with a few minor changes and additions, a Model Law that had been drafted at the National Bureau of Standards. Since that time this document has been subject to continued study and revisions, additions, and deletions have been made as needed. Thus was made available to the States a model upon which individual State legislation could be patterned.

Supplemental to the Model Law are codes of specifications, tolerances, and regulations for commercial weighing and measuring devices which receive especially critical attention, because many of the States officially adopt these requirements by reference or citation with cumulative provision, resulting in their being given legal status upon adoption by the Conference and publication by the National Bureau of Standards. Manufacturers of equipment are guided in their engineering designs, and essentially all weights and measures inspectors aline their procedures, according to the Conference codes.

8. Refinement of Values for the Yard and Pound

When the National Bureau of Standards began its work in 1901 the principal units of weights and measures in the U.S. customary system were defined as follows:

$$1 \text{ yard} = \frac{3600}{3937} \text{ meter}$$

1 pound = 0.453 592 427 7 kg
1 gallon = 231 cubic inches
1 bushel = 2 150.42 cubic inches

These definitions remained unchanged for 58 years, and the last two are still the official values.

The precision requirements in length measurements increased greatly during these years, and the differences between the U.S. inch and the British inch became especially important in gage-block standardization. The difference between the U.S. pound and the British pound was also rather annoying. As a result of many years of preliminary discussion, the directors of the national standards laboratories of Australia, Canada, New Zealand, South Africa, the United Kingdom, and the United States entered into agreement, effective July 1, 1959, whereby uniformity was established for use in the scientific and technical fields. The equivalents 1 yard = 0.9144 meter (whence 1 inch = 25.4 millimeters) and 1 avoirdupois pound = 0.453 592 37 kilogram (whence 1 grain = 0.064 798 91 gram and 1 avoirdupois ounce = 28.349 523 125 grams) were adopted for each of these national laboratories. It will be noted from the U.S. announcement (see appendix 5, p. 28) that these same equivalents will also be used in this country in trade.