AT Harvard University, Dr. Arthur Becket Lamb, since 1925 Sheldon Emory professor of chemistry and since 1912 director of the chemical laboratory, in charge of the new Mallinckrodt and Converse Laboratories recently completed, has been elected to the Erving professorship of chemistry in succession to the late Theodore W. Richards. He will be succeeded as Sheldon Emory professor by Dr. James Bryant Conant.

DR. ERNEST M. HALL, formerly of Stanford University, has been appointed professor of pathology and bacteriology in the school of medicine of the University of Southern California.

DR. SAMUEL VAN VALKENBURG, professor of geography at Clark University, has accepted appointment to the faculty of the City College of Detroit and will enter upon his new work in the autumn. He went to Clark University in 1927 after five years with the survey department of the Dutch government in Java.

AT Lehigh University, Associate Professor Lloyd L. Smail has been promoted to a full professorship of mathematics, and Dr. W. J. Trjitzinsky to an assistant professorship in the same department.

NON-RESIDENT lecturers who will take part in the summer session of Cornell University include Dr. Collier Cobb, professor of geology in the University of North Carolina; Dr. Arthur H. Compton, professor of physics in the University of Chicago, and Dr. P. S. Kupalov, professor of physiology in the Institute of Experimental Medicine, Leningrad.

IN German universities, Dr. Paul Krüger, professor of botany at Berlin, has been called to Vienna; Dr. Friedrich Hund professor of theoretical physics at Rostock, has been called to Leipzig, and Dr. Theodor Kaluza, professor of mathematics at Königsberg, has been called to Kiel.

DISCUSSION

THE REPORT OF THE NATIONAL ACADEMY OF SCIENCES ON REAPPORTIONMENT

ALL controversy concerning the mathematical aspects of the problem of reapportionment in Congress should be regarded as closed by the recent authoritative report of the National Academy of Sciences, signed by Professors G. A. Bliss, E. W. Brown, L. P. Eisenhart and Raymond Pearl, and printed in the Congressional Record for March 2, 1929. The National Academy is the body legally appointed to advise Congress on scientific questions, and the report mentioned was prepared at the request of Speaker Longworth of the House of Representatives.

The report lists the following five methods as the only ones that require consideration: "method of smallest divisors, method of the harmonic mean, method of equal proportions, method of major fractions and method of greatest divisors." These five methods are listed in the order in which they "favor the larger states," the first method favoring the larger states the least, and the last method favoring the larger states the most. In particular, the report points out, "the method of the harmonic mean and the method of major fractions are symmetrically situated on the list," so that "mathematically there is no reason for choosing between them"; and the same remark applies to the method of smallest divisors and the method of greatest divisors. (Incidentally, the list of five methods regarded by the academy as the only methods worth considering does not include the "method of minimum range.")

After full consideration of these five methods, *the report concludes that the "method of equal proportions" is the method to be preferred, for two reasons: first,* "because it satisfies the test [of a desirable apportionment] when applied *either* to sizes of congressional districts *or* to numbers of representatives per person"; and *secondly,* "because it occupies mathematically a neutral position with respect to emphasis on larger and smaller states."

The appearance of this statement from the National Academy which confirms authoritatively the established mathematical theory is particularly timely, since Congress has been in serious danger of being confused and misled by an erroneous theory. (See SCIENCE, December 14, 1928, and March 8, 1929.) The first reason given by the academy for adopting the method of equal proportions completely disproves the erroneous notion that there is some necessary conflict between the test as applied to "sizes of congressional districts" and the test as applied to "numbers of representatives per person," since *both* forms of the test are satisfied by the method of equal proportions. The second reason given by the academy completely disproves the erroneous notion that the method of equal proportions is unduly favorable to the smaller states, since this method is the one method which "occupies a neutral position" in the list, and does not favor either the larger or the smaller states.

The method which is at present competing with the method of equal proportions is the method of major fractions which was devised by Professor Willcox in 1910 and used in the apportionment for that year, more than a decade before the clarifying modern mathematical theory of the problem became available. The hold which this now obsolete method still maintains on the imaginations of many congressmen is due mainly, it appears, to a misconception of the meaning of the term "major fractions." The simple ideas which are associated with the name major fractions are hold-overs from the Vinton method, with which Congress was familiar from 1850 to 1900, or from the primitive scheme proposed by Daniel Webster in 1832, and do not apply at all to the much more complicated process now known as the method of major fractions.

It has been contended that when it comes to an actual vote in Congress, the method of major fractions has a "marked advantage" over the method of equal proportions, not because it gives a fairer or more equitable apportionment—which it does not do—but because Congress likes to have before it, as "on every previous occasion," a "table," containing a "constant divisor" and a "series of quotients" in which "each fraction larger than one half" gives an additional member. (Science, February 8, 1929.)

Why should Congress be so attached to a table of this particular sort? Obviously because when a congressman sees a quotient like 35.85 after the name of a state like Pennsylvania, he naturally supposes that Pennsylvania is theoretically entitled to a voting strength of 35.85. It is only on this supposition that he feels that 36 is a fairer allotment than 35. But is this supposition justified? Do the quotients in such a table really represent the allotments to which the states would be entitled in a theoretically perfect apportionment? The answer obviously depends on the nature of the constant divisor by which these quotients are obtained. How is this "constant divisor" selected?

Here is the point where the name "major fractions" is thoroughly misleading. In the Vinton method, which was used on every occasion from 1850 to 1900, the "constant divisor" was obtained in the natural and obvious way, as the result of dividing the total population of the country by the total number of representatives, and therefore truly represented the average size of the congressional district. Under the Vinton method, the series of quotients obtained from the constant divisor did actually "sum up to 435" (or whatever the size of the House then was). Under these conditions the series of quotients did represent, in a simple sense, the true amount of representation to which the several states were theoretically entitled, and the fractions occurring in those quotients had a certain legitimate interest.

But this is not true in the method used in 1910. The Willcox divisor is not obtained by dividing the total population by the total number of representatives, and is not in any sense the standard size of a congressional district. The Willcox "quotients" are totally unlike the quotients to which Congress was accustomed from 1850 to 1900, and have no relation to the exact amount of representation to which the states would be entitled in a theoretically perfect apportionment. The "whole series of quotients" does not sum up to 435.[1]

The following example will illustrate the complicated and artificial character of the Willcox divisor. Twenty-two representatives are assigned to the six states A–F by the method of major fractions (MF). The true ratio of population per representative is 250,000. The exact quota obtained by dividing the population of any state by 250,000 shows the voting strength to which that state would be entitled in a theoretically perfect apportionment, and the series of exact quotas sums up, of course, to 22.

State	Population	(250,000) Exact quota	MF	(229,500) Artificial quotient
A	1,494,000	5.976	7	6.510
B	1,260,000	5.040	5	5.490
C	1,030,000	4.120	4	4.488
D	801,000	3.204	3	3.490
E	572,000	2.288	2	2.492
F	343,000	1.372	1	1.495
	5,500,000	22.000	22	23.965

The artificial divisor, 229,500, which yields the series of artificial quotients in the last column, is determined by a complicated process which Professor Willcox himself admitted, in 1911, is "somewhat difficult to explain." These artificial quotients sum up to nearly 24 instead of 22, and bear no relation to the true quotas. It will be observed that state A, whose theoretical voting strength is less than 6, actually receives 7 representatives under the method of major fractions. (If the Vinton method or the method of equal proportions had been used in this example, state A would have had 6 and state F would have had 2.)

[1] Professor Willcox's article in Science, February 8, 1929, p. 164, contains the following paragraph, which is likely to give the erroneous impression that "the whole series of quotients" would sum up to 435: "If the secretary of commerce is called upon, for example, in 1930 to apportion 435 members by the method of major fractions, he would probably send to Congress not merely a list showing the number of representatives allotted to each state, but with it a table showing the population of each state by the latest census divided by a constant divisor and one representative allotted for each unit and each fraction larger than one half *in the series of quotients. The whole series would sum to 435.*" In Science for March 29, p. 357, however, Professor Willcox explains that this statement was ambiguous and that the "whole series" which would "sum to 435" was intended to refer not to the "series of quotients" but to the series of representatives. He agrees that the series of quotients does not sum to 435.

To attribute to the method of major fractions a simplicity which belongs only to an earlier process is a case of mistaken identity.

All these useless complications about "divisors" and "quotients" and "fractions" are completely done away with in the modern theory which provides a simple and direct test for the settlement of any dispute between two states. The whole story can be set down in a single paragraph as follows.

In theory, every state should be on a parity with every other state in the matter of apportionment. If in an actual case the congressional district in one state is, say, 10 per cent. larger than the congressional district in another state, then the "disparity" between the two states is said to be 10 per cent. *The method of equal proportions distributes the seats among the several states in such a way that any transfer of a seat from any state to any other state will be found to increase, rather than decrease, the disparity between the two states.* In other words, an apportionment made according to the method of equal proportions is one which can not be "improved" by any shift in the assignments.

This is a test which any one can apply to any given apportionment without any knowledge of the technical short-cut process by which the assignments may have been computed. (See the *Transactions* of the American Mathematical Society for January, 1928.) No "constant divisor" or "series of quotients" forms any part of the process.

The objection is sometimes raised that for purposes of measuring the disparity between two states the size of the congressional district is not so important, on constitutional grounds, as the "individual share" in a representative which each inhabitant possesses. This objection is not valid, however, because if the congressional district in one state is 10 per cent. larger than the congressional district in another state, then also the "individual share" in the second state will be 10 per cent. larger than the individual share in the first state, so that the disparity between the two states remains 10 per cent., whichever basis of measurement is adopted. No question of constitutional interpretation is here involved, because either of these two interpretations is satisfied by the method of equal proportions better than by any other method.

The choice of the wrong method may give incorrect representation to a large number of states. In 1920, six states would have been incorrectly represented if 435 members had been apportioned by the method of major fractions. In 1930, if the estimated populations prove to be in error by only 2 or 3 per cent., a case may arise in which 22 states would be incorrectly represented.

The report of the National Academy of Sciences confirms the earlier report of the advisory committee to the director of the census, which concluded that "the method of equal proportions, *consistent as it is with the literal meaning of the words of the constitution,* is logically superior to the method of major fractions." The purely political attempts which have been made to retain the obsolete method of major fractions in current legislation have proved to be a serious menace to the whole reapportionment movement.

EDWARD V. HUNTINGTON
HARVARD UNIVERSITY

THE RATE OF WORK DONE BY A RICKSHA-COOLIE

A PECULIARITY of the Chinese street scene is a vehicle strange to Europeans, but used in East Asia, the ricksha. To the physiologist the man drawing the ricksha is especially interesting, for the ricksha-coolie is a man trained for one special movement only, fast locomotion.

Two kinds of running can be distinguished: (1) Relatively slow running with 100 double paces in one minute and with a length of step up to 210 cm. The foot is posed in the same manner as in walking. The sole touches the ground completely during a short time before pushing off with that foot. (2) The second kind of running, making possible a quicker locomotion, involves contact only between the toes and ball of the foot and the ground; but this kind of running can not be continued for any long time.

In the ricksha-coolie there is a rolling motion of the foot, which is both directly visible and demonstrable in photographs. It is characteristic of the first kind of running, and corresponds with the length of the step. In order to demonstrate this I marked off in a very busy street a measured distance, and from a window situated not very far from the street I counted the steps taken by ricksha-coolies in covering this distance. This method has the advantage that the observed person is not aware of being observed, and the length of step is that usually employed. Unlike laboratory experiments all movements are unconstrained and show no more than normal power. In my observations the double step was from 130 up to 200 cm long, depending upon the degree of fatigue. According to Weber a step of 210 cm length forms the border beyond which only the toes and ball of the foot touch the ground.

The number of paces in a minute varied between seventy-six and eighty-seven. The velocity of forward movement of the body was from 109 to 162 m in a minute, or from 6,600 to 9,700 m in an hour.