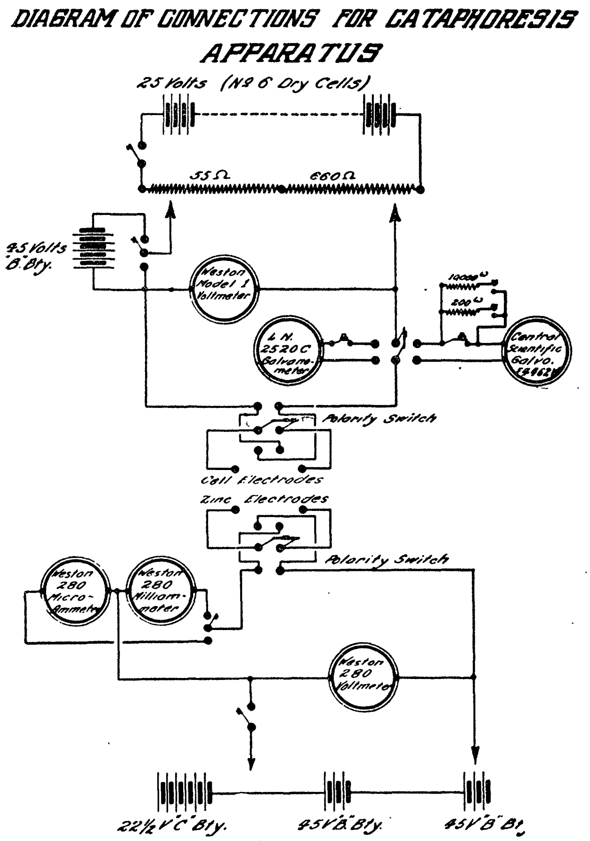

FIG. 1

Polarization may take place if any appreciable current is drawn from the cell electrodes. It is therefore advisable when balancing a circuit not to depress the key switches longer than is necessary to cause deflection of the galvanometer. After a little experience this difficulty is never encountered.

The method and apparatus herein described have been used for several months with a Northrup-Kunitz design of cataphoresis apparatus, and has proved to be of distinct value in controlling experimental work.

The author wishes to express his appreciation of the advice and assistance given by Captain R. A. H. Galbraith, of the Royal Canadian Corps of Signals.

JAS. GIBBARD

THE MEASUREMENT OF ARM GIRTH

FRANZEN has emphasized arm girth and calf girth in measures of growth and nutrition.[1] The instrument in common use for obtaining these measures is a tape wound about a coiled spring in a small metal case. To keep the tension more or less constant in measurements, a handle is provided with a spring to balance the spring of the case.

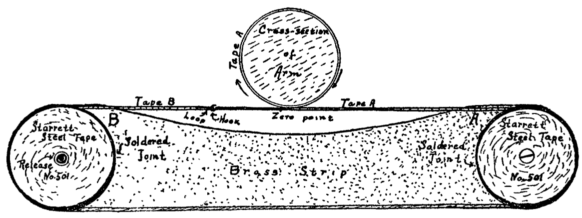

FIG. 1

The figure printed herewith is a drawing to illustrate a method of mounting two steel tapes so that the tension of one may be balanced by that of the other.[2] When one tape has been looped around the member to be measured, it is attached to the end of the other and both springs are released by the pressure of the thumb of one hand and a finger of the other. Tension is thus controlled automatically. The instrument, which may be called a girthometer, is entirely practicable, having been used for measuring thousands of arm girths under the direction of the writer.

H. T. MANUEL

UNIVERSITY OF TEXAS

SPECIAL ARTICLES

THE LOGISTIC CURVE AND THE CENSUS COUNT OF 1930[1]

EARLY in 1920 we published[2] the results of fitting a logistic curve to the census counts of the population of the United States from 1790 to 1910, inclusive. At the time the computations were made in 1919 the results of the census of 1920 were not available, and therefore were not and could not be included in the calculations. Soon after the original paper was published the notation was improved, and the curve took the definitive form, still, however, *without* the use of the 1920 count,

$$y = \frac{197.27}{1 + 67.32\,e^{-0.0313x}} \qquad \text{(i)}$$

[1] From the Department of Biology and the Department of Biostatistics (Paper No. 153), of the School of Hygiene and Public Health of the Johns Hopkins University.

[2] Rearl, R., and L. J. Reed, "On the Rate of Growth of the Population of the United States since 1790 and Its Mathematical Representation," Proc. Nat. Acad. Sci., Vol. 6, pp. 275–288, 1920.

[1] R. Franzen, "Physical Measures of Growth and Nutrition," American Child Health Association, 1929.

[2] The writer was assisted in making the first of these instruments by Mr. Wm. Sachs. While no complete check of the literature has been made, nothing like it has been found in the references consulted. The instrument was devised for use in a study financed by the University of Texas Fund for Research in the Social Sciences.

where y denotes calculated population in millions, and x time, in base units of one year.

A basic implication of the logistic theory of population growth is that such growth proceeds in an orderly manner according to some law, to which the logistic curve may be taken as a first approximation, so long as the conditions under which the population is growing are not seriously or suddenly altered. Without any thought of implying the possession of any knowledge as to whether, or when, or by how much, the conditions under which the population of the United States had grown between 1790 and 1910 might change subsequent to 1910, we did, as a matter of interest, in our original publication discuss the extrapolation to the year 2100 of the equation given above. At that date this particular curve will be very close to its asymptote of 197.27 million. This logistic curve has not lacked attention in many places and from various persons. It has, in fact, been much discussed, sometimes with approval and sometimes with disapproval. Throughout the mild tempest which has raged about the logistic theory of population growth during the past decade the authors of this paper have refrained from altering the logistic equation for the United States from its original form reprinted above, having seen no reason to do so, and being content to await the passage of time and the course of events to furnish an impartial judgment regarding its validity and usefulness.

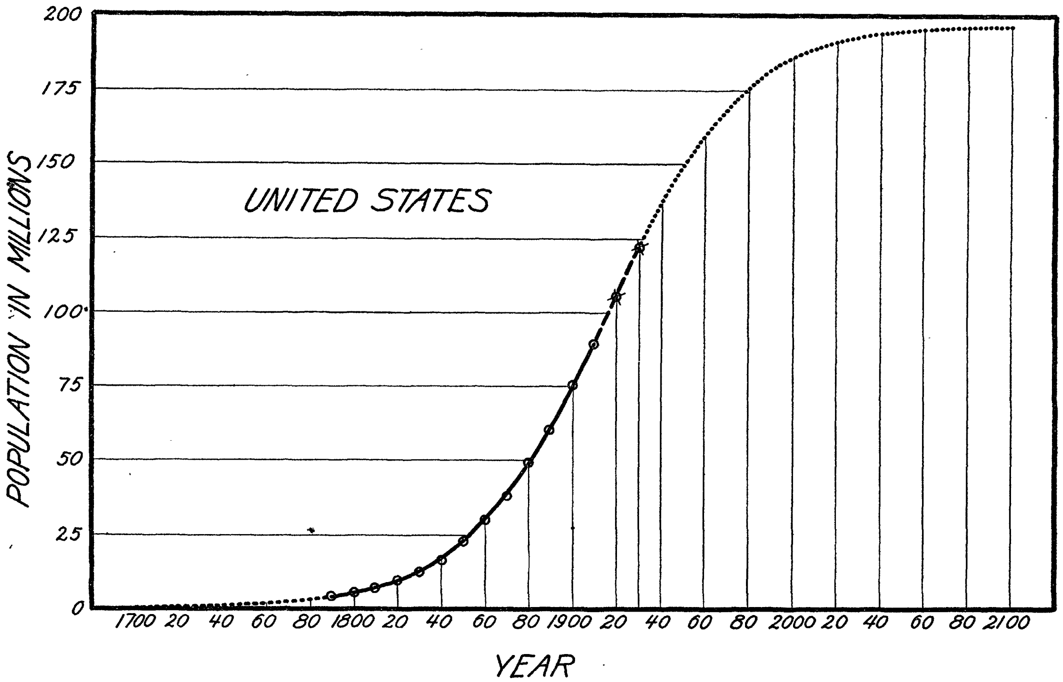

FIG. 1. The census counts of the population of the United States from 1790 to 1930, inclusive (given by circles). The smooth curve is the logistic of equation (i) above fitted to the census counts from 1790 to 1910 inclusive. The broken lines show the extrapolation of the curve beyond the data to which it was fitted. The dash portion from 1910 to 1930 is the part of the extrapolation which has been tested by census counts (crossed circles) which have been made since the logistic was originally fitted. The dotted line shows the further extrapolation of the same curve.

Twenty years have elapsed since the last *datum* (the census count of 1910) available when the curve was calculated. It seems justifiable now to make some examination of how the case goes. The following little tabulation, and Fig. 1, give the facts.

Population of Continental United States (in millions)

	A. As forecast by logistic equation (i) (data of 1790–1910)	B. As counted by the Census Bureau
1920	107.4	105.7
1930	122.4	122.7

It thus appears that the forecast of the logistic curve (equation (i)) missed the counted population by *16 parts in a thousand* in excess in 1920, and by *2.5 parts in a thousand* in defect in 1930.

In conclusion, we wish again to emphasize, as we have repeatedly in the past, that it is a basic postulate of the logistic theory of population growth that any particular population can be expected to continue to follow in its later growth the same logistic curve which it has followed in its earlier growth *only* if there has been no serious or cataclysmic alteration of the conditions (climatic, geological, biological, economic or social) under which its earlier growth has taken place. The present evidence indicates that the population of the United States during the period 1910–1930 continued in its growth along the same logistic curve that it had followed in the period 1790–1910.

RAYMOND PEARL
LOWELL J. REED

LIGNIN AS A POSSIBLE FACTOR IN LODGING OF CEREALS

LODGING is the laying over of the cereal plants at a period when their vegetative growth is nearly completed. It interferes with the normal development of the grain, frequently causing a loss of from five to ten bushels per acre.[1] The accepted opinion is that lodging is generally caused by nitrogenous overnutrition, as it occurs most frequently on naturally fertile soils rich in humus and on soils heavily fertilized with manure or inorganic nitrogen carriers. Lodging is consequently more of a problem under conditions of intensive cultivation than under those of extensive cultivation.

The immediate causes of lodging have been a matter of controversy for more than a century. Sir Humphry Davy[2] in 1798 associated lodging with a low silica content of the straw, although, as was characteristic of his time, his views were based largely on speculation. In 1842 Liebig,[3] the "father of agricultural chemistry," also attributed lodging to a deficiency in silica. His views were supported by a number of investigators but were opposed by the pioneer plant physiologist Sachs[4] and others. In 1900 Swiecicki,[5] after a thorough analysis of the opposing views of Liebig and Sachs and their respective followers and on the basis of his own experiments, upheld the view that lodging is caused by a deficiency in the silica content of the straw. He found that the silica content was invariably lower in lodged oats and barley than in normal crops of these cereals grown under comparable conditions. More recently Headden[6] and Davidson and LeClerc[7] found that the application of sodium nitrate, which frequently causes lodging, depressed appreciably the ash and silica content of wheat straw. In view of all this evidence pointing toward silica deficiency as a possible factor in lodging, it is remarkable that Welton,[1] who recently made an extensive investigation of the causes of lodging, did not deem it necessary to include ash and silica in the analytical examination of his materials.

Another factor which is considered as one of the causes of lodging is a deficiency in the lignin content of the plants.[1,4] It has been assumed that lignin lends mechanical support to the stalks, thus preventing them from falling over. The Bureau of Chemistry and Soils has undertaken to ascertain whether or not lignin is a factor involved in lodging of cereals.

Two wheat plots, about 1/50 acre each, were selected in the same field on the Arlington Experimental Farm. One received no fertilizer treatment and served as a control; the other received early in spring sodium nitrate at the rate of 600 pounds per acre, obviously a high application for wheat. The wheat on the fertilized plot grew luxuriantly but suffered from characteristic lodging close to the "milk" stage of the grain. That on the control plot remained erect until harvested. Samples cut from the two plots at frequent intervals up to maturity were analyzed for total ash, silica and other ash constituents, and lignin.

The results, which will be published in full elsewhere, corroborate those of Swiecicki and of Davidson and LeClerc mentioned above. The silica and ash content in the straw from the fertilized-lodged plot was in every case lower than from the control plot.

What came as a surprise, however, was that, contrary to the views of Sachs and of Welton, the lignin content of the straw from the fertilized-lodged plot was distinctly higher in every case than of that from the control plot. Accordingly, should the cause of lodging be sought in lignin-content variations between the lodged and erect plants, the conclusion would have to be reached that a high and not a low lignin content is the cause of lodging. This is in accord with the recent work of Dadswell and Hawley,[8] who found that brash specimens of Douglas fir contained a higher lignin content than tough specimens. It

[1] F. A. Welton, "Lodging in Oats and Wheat," *Bot. Gaz.*, 85: 121, 1928.

[2] Davy, "Elements of Agr. Chemistry," p. 51, 1813.

[3] Liebig, "Die Chemie in ihrer Anwendung auf Agriculturchemie und Physiologie," 1 Theil, "Ernährung der Vegetabilien," p. 168, 1862.

[4] Sachs, "Experimental-Physiologie der Pflanzen," p. 150, 1865.

[5] Vitold von Swiecicki, "Die Anwendung der Kieselsäure als Bestandteil der Pflanzen und ihre Beziehung zum Lagern des Getreides," Berichte aus dem Physiologischen Laboratorium und Versuchanstalt des Landwirtschaftlichen Instituts der Universität Halle, p. 66, 1900.

[6] W. P. Headden, "A Study of Colorado Wheat," Part III, Colo. Exp. Sta. Bul. 219.

[7] Jehiel Davidson and J. A. LeClerc, "Effect of Various Inorganic Nitrogen Compounds Applied at Different Stages of Growth on the Yield Composition and Quality of Wheat," *Jour. Agr. Res.*, 23: 55, 1923.

[8] H. E. Dadswell and L. F. Hawley, "Chemical Composition of Wood in Relation to Physical Characteristics. A Preliminary Study," *Ind. Eng. Chem.*, 21: 973, 1929.