that the force exerted on them appears to diminish with time. Now the electrical conductivity of grey, crystalline selenium, cooled suddenly from above 200°C ., rises to a maximum and then steadily decreases with time. In the condition of maximum conductivity the selenium has pronounced metallic properties, and this suggests that the strongly light-positive selenium is of this kind, and becomes gradually transformed into a more stable and less light-positive modification as time proceeds. Tellurium appears to behave similarly.

In continuation of Arrhenius's work on comets' tails, Schwarzschild applied the theory of light pressure to objects of the order of magnitude of the wave-length of light, and showed that a scattering of the incident energy occurs on such particles. For any one kind of matter there is, as a consequence, a definite size of particle for which the ratio of the impressed force to the incident energy is a maximum. It is interesting to note that Ehrenhaft found a maximum velocity for particles of a substance of a particular size, the critical radius for silver (light-positive) being in accord with the demands of theory, viz. $9.8 \cdot 10^{-6}$ cm. But a maximum velocity exists also for light-negative particles, the critical radius being $26 \cdot 10^{-6}$ cm. for sulphur and $15 \cdot 10^{-6}$ cm. for light-negative selenium particles. In the interpretation of light-negative photophoresis, for which no theory at present exists, it must not be overlooked, however, that spherical particles, say, of sulphur or selenium are apparently attracted by the light, even when their dimensions correspond with several wave-lengths of light.

An interesting astronomical application of the phenomenon of photophoresis has been suggested by F. Zerner (*Phys. Zeit.*, xx., 93, 1919) to explain those anomalous comets' tails, which are directed towards the sun. He refers to the observations by I. Schmidt (Athens) of the 1882 comet, and suggests that whereas normal comets' tails may be composed of light-positive matter, it seems equally probable that anomalous comets' tails are made up of light-negative material. Ehrenhaft's laboratory separation of elements by photophoresis would thus seem to have an analogon in astronomy, and doubtless this point will form the subject of much interesting research in the future.

ROBERT W. LAWSON.

STANDARDS OF MASS.

A CIRCULAR recently issued by the United States Bureau of Standards¹ furnishes information concerning the verification of standards of mass and the most suitable forms of such standards for different purposes. An account is first given of the fundamental and national standards of mass of the United States. The standard is the kilogram, from which the pound is derived by the relation 1 lb. avoirdupois = 0.4535924277 kilogram, a relation which shows that the avoirdupois pound of the United States is the same as the British pound. The distinction between mass and weight is then considered, and it is explained that weight is measured in units of force, and that, as it is not feasible for the purposes of metrology to base the unit of force on some concrete standard force, the unit is derived from the established units of mass and acceleration.

The next section of the Circular is a convenient classification of weights, describing the forms recommended for particular classes of work. Weights intended to be of high precision, such as the primary standards of the various States of the Union or

reference standards used by first-class manufacturers, are only accepted for verification at the Bureau if they comply with a certain specification as to material, form, and structure. Unless they are made of platinum or a metal which resists atmospheric corrosion, they must be protected by a plating of gold or platinum. Nickel-plating is not allowed. The material and plating must be such that no discoloration appears on the surface of the weights when they are placed in boiling water or when dried at a temperature of 110°C ., as is done in preparing them for test. Manufacturers are advised that in machining such weights the knob, top, and sides should be finished first, next the outer rim of the bottom, and then the central portion of the bottom hollowed out by an amount approximately equal to the volume of the knob. The preliminary adjustment should be completed in the last operation.

As regards the adjustment of commercial test-weights, it is of great practical importance that the means of closing the adjusting hole shall be such that the weights can be readily readjusted, but that the operation shall necessarily involve the defacement of the stamp. Various forms of adjusting plugs suitable for such weights are illustrated and described.

The second half of the Circular is devoted to the verification of weights and the reduction of observations. The different methods of weighing are described and the particular purposes are indicated for which each method is most appropriately applicable. Illustrations are given of the various weighing forms in use at the Bureau, and examples of the methods of comparison, as well as of the computations, are set out in a very explicit manner. The important question of the correction for the buoyancy of the air is very fully treated. As regards the determination of humidity, it is pointed out that the hair hygrometer is almost the only form of instrument that can be used inside a closed balance-case. Such hygrometers should not be verified by placing them in saturated vapour, as this leaves them almost worthless for some time. Brief tables for use in the reduction of observations are appended, and the work is concluded by two very convenient tables giving the equivalents of avoirdupois pounds in kilograms, and *vice versa*, from 1 to 999 in each case.

In its present extended form this Circular is a typical example of the useful publications issued by the Bureau, the aim of which is not only to aid scientific investigation, but also to encourage and facilitate the employment of scientific methods in the commercial world.

THE FOLK-SONGS OF THE TETON SIOUX.¹

THE tribe of American Indians selected by Dr. Densmore for the researches now published is the Teton division of the Dakota Sioux tribe, to which the United States Government in 1868 assigned the portion of territory known as the Standing Rock Reservation, comprising some twenty million acres of the provinces of North and South Dakota. Strictly speaking, "Dakota" is the name applicable to the natives rather than to the region, and the largest division of the tribe or nation was known as *Ti'ton'wan*, whence the contraction Teton.

The author, who had previously published two volumes on Chippewa music, has now transcribed, with the help of the phonograph, more than six

¹ "Design and Test of Standards of Mass." Circular of the Bureau of Standards. No. 3, 3rd edition, pp. 89. (Washington, 1918.)

¹ "Teton Sioux Music." By Frances Densmore. Pp. xxviii+561+82 plates. Smithsonian Institution, Bureau of American Ethnology, Bulletin 61. (Washington: Government Printing Office, 1918.)

hundred songs, which are recorded and analysed in the present volume. It will thus be seen that the tribe possesses a very elaborate system of folk-songs, mostly associated each with a particular object, and it is to be noted with interest that, with the advent of civilising influences, phonographs have become much sought after by the Sioux themselves.

The distinctly tribal life of the Teton Sioux practically ceased with the suppression of the Sun Dance, the last of which was held in 1881, the final buffalo hunts occurring in the two following years. The sun dance was a most elaborate religious ceremony, in which the sun symbolised the Divine Power. It lasted several days, and, besides the complex ritual involved in the raising of the Sacred Pole and other observances, the leading feature was the self-infliction of bodily torture by the participants as a sacrifice to their deity. In the most severe forms this involved suspending the bodies of the willing victims by skewers and thongs driven through their flesh in the fierce heat of the sun until the victims tore themselves down, lacerating their flesh in the process. In addition, the whole of the assembly would go without food and drink for several days during this period. Each phase of the ritual had its special song. The natives even now deplore the substitution of the white man's religion and education for what they regarded as a discipline in heroism and bravery. It is stated that boys used to go through a miniature copy of the ritual in which they aspired to participate when of adult age.

Another group of songs is associated with certain societies existing in the tribe. Some of these, called Dream Societies, are constituted of individuals who are distinguished by the particular animals which appeared to them in dreams, such as the badger, buffalo, or elk; others were of a military character.

The only musical instrument which figures in most of these songs was the drum, which was of the usual type, but in the sun dance a stiff rawhide was also beaten. The author also refers very briefly to two whistles, one of bone used in the sun dance, the other of wood used in grass dances, which latter is capable of emitting a series of harmonics.

The tone-scale of the songs approximates to the well-known five-tone scale represented by the black keys of the piano, but the intervals are in reality a little different. A noticeable feature is a more or less marked resemblance to some of our present "modern" music, both in the absence of well-defined melody and in the irregularity of the rhythm. A few of the songs, indeed, do appear to possess something in the nature of a tune in them; in others the sequence of notes is very much of the same chaotic character that is so conspicuous at modern recitals. Again, in the rhythm one bar is often in three-time and the next in four—an artifice which Brahms knew how to use with good effect, but which is now commonly employed in order to render music unlovely, and therefore what is described as "thrilling." Again, the voice part is frequently independent of the drum rhythm, the latter being usually in more regular time. It might thus be possible that if suitable harmonics, or rather discords, were added, these songs might appeal to the class of present-day concert-goers who appreciate the attempts of modern pianists to represent "Le Raid des Zeppelins."

What, however, is much more important is the glimpse which this unique collection affords of the highly complex system of primitive poetic and musical art that this tribe of American Indians had built up, which is fast becoming obsolete under the social and educational influences brought into force by the white races.

G. H. BRYAN.

ELECTRICAL PURIFICATION OF CLAYS.

THE phenomena known as electrical endosmosis and cataphoresis, whereby matter in a very finely divided or colloidal state is capable of being influenced by an electrical potential, have been extensively investigated. For instance, when a colloidal solution of arsenious sulphide is placed in a cell and a direct current at a potential of 100 volts passed from suitable electrodes through the solution, the colloidal particles tend after a time to collect round the positive pole, leaving a clear zone round the negative pole.

It is found that nearly all substances, if in a sufficiently fine state of division, are attracted either to one pole or the other. It has also been observed that aggregates of certain fine particles can be dispersed and separated by adding to the fluid in which they are suspended minute quantities of alkali in the case of those particles attracted to the positive pole, and of acid to those which are attracted to the negative pole. Moreover, if the particles are not sufficiently susceptible to the dispersive effect of the added electrolyte, they can be made so by being allowed to adsorb some colloid, such as colloidal silicic acid.

This latter discovery has a most important bearing on the clay industry. China clay and ball clay are examples of such aggregates of fine particles, and if a thick slip is made up of the clay and water the addition of small amounts of alkali causes the clay particles to disperse, and the slip, as a consequence, to become much thinner and more mobile, the clay particles remaining in suspension a considerable time and exhibiting vigorous Brownian movement. On passing a current of electricity through such a suspension, the clay particles collect and adhere closely to the anode plate, the water collecting in a zone, substantially free from clay, round the cathode. Impurities in the original clay, such as mica, quartz, feldspar, and iron compounds, are either unaffected by the electrical potential and settle out, or attracted to the cathode. A means of purifying clay on a commercial scale can thus be evolved from a consideration of the above phenomena, as was shown by the exhibit of raw and purified clays of the Osmosis Co., Ltd., at the recent British Scientific Products Exhibition.

The commercial equipment for such a process consists of a blunger, settling tanks to allow the coarse impurities to settle out of the suspension, and an Osmosis machine composed of a rectangular trough in which is arranged horizontally a cylindrical metal anode surrounded beneath the surface of the slip and at a short distance away from it by a cathode through which, by paddles or other means of circulation, the clay slip is driven. The cylinder is made to revolve slowly, and by means of a scraper the dried purified clay, containing 20-30 per cent. of water, is collected.

The machine not merely collects the suspended clay and frees it from water, but subjects the suspension to an electrical purification as well, for should there still be in suspension with the clay minute particles of mica, iron, and silica that have not had time to settle out in the tank, these are not attracted to the anode, but for the most part remain in the effluent leaving the trough. Consequently, electrically osmosed clay is a purer product than can be obtained by any method of settling or centrifuging.

The improvements effected by the process are:—(1) Pyritic and other forms of uncombined iron are removed. (2) The sintering temperature of the clay is lowered so that a lower kiln-temperature can be employed, with consequent saving of fuel. (3) Clay can be graded into different degrees of fineness.