wholly in black, and narrow bands of some bright metal are placed down his arm, thigh, and leg, following precisely the direction of the bones of these parts. This arrangement allows us to easily increase tenfold the number of images received in a given time on the same plate: hence, instead of ten photographs a second, we can obtain one hundred. For this, the rapidity of rotation of the disk is not altered; but, instead of one opening, there are ten, equally distributed on the circumference. One of these openings must have a diameter twice that of the others. The result is a much larger size for one of the images; and this renders the estimation of the time easy, and also furnishes data to compare the movements of the lower and upper limbs. The images obtained under these circumstances are so close, that one is present, as it were, at all the successive changes of place of the limbs and body. Thus, in fig. 8, between two successive touches of the ground by the right foot, there are twenty-one different positions of the lower limb. As the foot meets the ground, the knee is bent perceptibly; then it straightens as the foot, resting on the toes, prepares to leave the ground. After the raising of the foot, the knee bends again, and the leg forms with the thigh a right angle; then it gradually becomes straight, and the sole of the foot, which was at

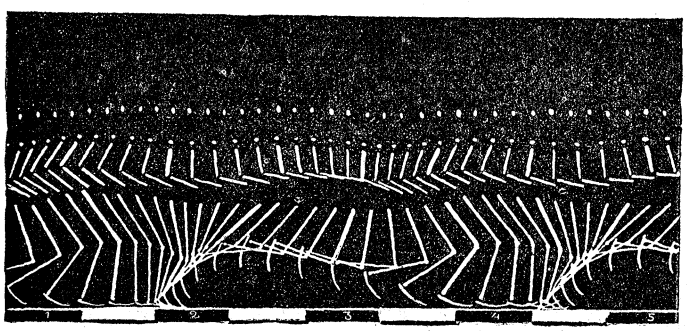

FIG. 8.

first in a vertical plane, is apparently parallel to the ground which it touches for some time before it rises again. The scale at the bottom of the figure shows that the total length of the step was 2.6 metres. The chronograph was not used in this experiment, but we may estimate the number of images at about sixty a second. The movements of bending and extending the fore-arm are obtained in the same manner as those of the leg. The turnings of the head are expressed by the undulatory motion of a bright point placed on a level with the ear. In short, the diminutions and the accelerations of each part are expressed by the crowding or separation of the images. To ascertain the corresponding positions of the arm and leg at a given instant, we take for data every fifth figure, which is larger than the others. These images are formed at the moment of passage before one of the larger openings; and they correspond, therefore, to the same instant of time. This is not the place to analyze in detail the various types of locomotion. The few examples just given sufficiently explain the method, and show its exactness. For a complete study of human locomotion, photographs under the most diverse circumstances must be obtained. The subject must be photographed not only from the side, but also from the front and rear, in order to show the lateral oscillations of the different parts of the body. Finally, after studying the mechanism of the various motions produced in walking or running, the final result — the more or less rapid transportation of the man — must be studied, either as he walks freely, or as he bears or draws a burden.

These researches have a practical interest, even as those having for their object the determination of the product of machines, and the most favorable conditions for this production. Experiments in regard to this are in process; and it is with this object in view that the circular course with telegraphic signals, to note the phases of the walking or running, has been established.

THE FUNDAMENTAL CATALOGUE OF THE BERLINER JAHRBUCH.

A VERY important comparison by Dr. Auwers, of the fundamental catalogue of the *Berliner jahrbuch* with those of the *Nautical almanac*, the *Connaissance des temps*, and the *American ephemeris*, appears as a supplement to the *Jahrbuch* for 1884; and the following abstract of it is given. The year 1883 is the first in which such a comparison is possible.

The *Berliner jahrbuch* contains at present, and will contain for the future, 450 stars whose apparent places are given, and 172 stars for which only mean places are printed; i.e., 622 in all. The places of these stars, both in R. A. and Dec., depend strictly on the system of the Fundamental catalogue of the *Astronomische gesellschaft* (publ. xiv.). They lie between the north pole and — 31°.3 declination.

The *American ephemeris* contains the mean places of 383 stars, for 208 of which ephemerides are given: 44 of these stars lie south of —31°. The *Nautical almanac* has 197 stars (15 south of —32°), and ephemerides are given for all. The *Connaissance des temps* has 310 stars between the north pole and — 70°, and gives an ephemeris for each.

Dr. Auwers's account of the sources from which the star-places of the various almanacs are taken we omit. It shows how various these are. 450 stars have ephemerides in the *Jahrbuch;* 149 stars (mostly southern) which have ephemerides in the three other almanacs are not contained in the *Jahrbuch*.

A table is given in Dr. Auwers's paper, showing the comparison between each star of each almanac and the *Jahrbuch*. From this table the elements by which the catalogue of each almanac can be reduced to the system of the *Jahrbuch* are deduced. A subsequent table gives the two reductions which must be added

to each almanac R. A., and the two reductions which must be added to each almanac Dec., in order to reduce to the system of the *Jahrbuch*.

The catalogue of each almanac, after the application of the systematic reductions from this table, is then compared with the Fundamental catalogue. For the *Nautical almanac*, the mean difference in declination is 0″.395; in R. A. (from 134 stars), 0ˢ.0332. Of the 168 stars common to both almanacs, there are 27 whose R. A. differs more than 0ˢ.067, and 8 whose declinations differ by more than 1″. These differences are, in the main, errors of the *Nautical almanac*, and are largely due to the erroneous proper motions adopted in the Greenwich catalogues.

For the *Connaissance des temps*, the table shows large systematic errors. After these have been eliminated, the comparison shows for 229 stars, common to the *Connaissance des temps* and the *Berliner jahrbuch*, a mean difference of 0″.373 in declination, and a mean difference of 0ˢ.0282 (from 162 stars) in R. A. The errors here, again, are largely due to erroneous proper motions.

The correspondence of the reduced positions of the *American ephemeris* with those of the *Jahrbuch* varies according as one or another basis of comparison is chosen. A complete comparison can only be made for those stars for which ephemerides are given, since the newer stars have their positions derived from several sources, not comparable among themselves.

The declinations of the *American ephemeris* and those of the *Jahrbuch* agree excellently for those stars which have been investigated by Boss. The mean difference (162 stars) is 0″.177. The other 111 stars do not agree so well, there being 12 differences between 0″.5 and 1″. The stars north of 64° depend upon Gould's R. A.; and, of the 36 stars common to both almanacs, 15 differ by more than 0ˢ.15. Of the remaining 126 stars whose ephemerides are given, 8 have differences as great as 0ˢ.067. The mean difference for 100 stars between +40° and −20° is 0ˢ.0127. For the 111 stars without ephemerides, there are seven cases where the difference is more than 0ˢ.067.

For the stars south of −32°, the *Nautical almanac* will give the best positions, on account of its data being derived from the most recent catalogues.

A comparison of the system of the *Jahrbuch*, 1861–82, with the new system, and a general table for the reduction of the data of any almanac to the *Berliner jahrbuch* system, concludes this very important paper.

It is to be hoped that in the immediate future all star positions may be reduced to the system of the *Jahrbuch*, and its admirable list of stars will be amply sufficient for observers in the northern hemisphere. For the determination of time and longitude, the stars of the other almanacs will serve a useful purpose, especially as they may easily be made homogeneous with the Berlin list by tables given by Dr. Auwers in this paper.

EDWARD S. HOLDEN.

Washburn observatory, University of Wisconsin, Madison, July 24, 1883.

LETTERS TO THE EDITOR.

English *ch*.

IN SCIENCE, ii. 452, you assert that the English '*ch* (in *chair*) is not a simple consonant, but a compound,' consisting of '*t* followed by *sh*, as is apparent in pronouncing with 'due lingering emphasis' the words, 'even *such* a man, so woe-begone,' etc. Now, the same length and emphasis may be produced by a prolongation or continuous repetition of the vowel-sound of the word 'such,' and, it seems to me, would be so in the case of anybody who was unacquainted with the *tsh* theory. But even if not, the change from a simple *ch* to a compound *tsh* would not be the only instance in the language, where under special circumstances, such as a prolongation or drawl, a sound is liable to an essential change; and it must be peculiarly so where the sound can be properly made only by an instantaneous movement. *Ch* seems to be caused by such a movement, just as a smack of the lips is, which is certainly a decidedly different sound from the one made in the same way, except more gently and slowly, — a *p* made with inward-drawn breath. The relation between the smack and that *p* seems to be the same as the relation between the English *ch* and *t*, and the difference in each case to depend on the mode of contact and of its interruption, not on any combination or succession of sounds.

Again: it appears quite possible to pronounce the word 'chair' perfectly with the teeth kept slightly open by the finger or a pencil, and held, therefore, in such a position that it is impossible to pronounce the word 'share' correctly, showing that *sh* is not properly a part of the *ch*.

Moreover, if *ch* is the same as *tsh*, or the German *tsch*, the Germans would at the outset have no difficulty in pronouncing the English *ch* in a way not noticeably different by its hissing sound from ours.

It has been said, that after pronouncing the word 'check' to a phonograph, on turning the machine backwards, the sounds re-appear as *kesht*; but is that not wholly due to an incorrect, prejudiced pronunciation of the first word, as if written *tshek*? L. B.

Nov. 9, 1883.

[Argument is out of place in reference to what is a matter of mere observation. The suggested experiment by 'lingering emphasis' ought to satisfy any ear as to the reality of the stopped or shut commencement of the sound of *ch* in *chair*, and of its hissing termination. L. B. evidently associates some meaning different from the ordinary one with the terms 'simple' and 'compound.' *Ch* is compound because its shut commencement and its hissing termination are elementary effects, each of which is susceptible of separate utterance. — EDITOR.]

Report of the Assos meeting.

Henry W. Haynes, Esq., calls my attention to an error in the remarks on Assos made by me at the meeting of the Archaeological institute, Oct. 31, and printed by you in your recent report (SCIENCE, no. 41).

For 'to fight against Ramses III. — the Rhampsinitos of Greek story,' read, 'to fight against Ramses II. — the Sesostris of Greek story.'

May I beg you to make this correction public.

JOSEPH THACHER CLARKE.

Boston, Nov. 19, 1883.

Analysis of the wild potato.

In the spring we received from Mr. J. G. Lemmon, Oakland, Cal., some tubers said to be of Solanum tuberosum, var. boreale, and collected in Arizona. Of