wheel is used, by leading the cord at an angle from the true parallel with the piston rod, which it should occupy at all positions of the crosshead. If a lever rig is used, the cord angle is made such as to give, for the first quarter or eighth of the outstroke, too little motion of the paper drum; and for the expansion period too much.

THE SUN-EARTH BALANCE.

By PLINY EARLE CHASE, LL.D.

The following is the shortest method which has ever been published for estimating the sun's distance. I believe that it is also the most accurate method, for the following reasons.

1. If the hypothesis of an all-pervading luminiferous æther is true, all its cyclical movements must be rhythmic, or harmonic, the various forms of rhythm being governed by various centres of oscillation.

2. The simplest kinds of oscillatory motion, in cosmical bodies, are linear and spherical.

3. Laplace showed, in discussing the motions of Jupiter's satellites, that whenever there are tendencies to simple numerical relations, in planetary arrangements, all the forces of the system combine to make those tendencies exact.

4. The sun is the principal centre of attraction, and the earth is the principal centre of condensation in the solar system.

5. The earth is also a centre of linear oscillation for a point in the orbit of Mars, a centre of rotary inertia for a superficial film of condensation or of luminous undulation in the same orbit, and a centre of rotary inertia for an æthereal sphere which has its limit in the asteroidal belt.

The action and reaction of æthereal waves, between these two important centres, have produced an amount of gravitation, at the earth's surface, which is sufficient to give a circular orbital velocity of $\sqrt{gr} = 4.9073$ miles per second. The linear oscillation of the earth around the sun, combined with the superficial resistance at the outer limit of the belt of greatest condensation, multiplies the energy by $\frac{3}{2}$, and the rotary æthereal oscillation multiplies it by $\frac{5}{2}$. Consequently, the earth's velocity of revolution, which measures the projection of *vis viva* against uniform resistance, is $\frac{5}{2} \times \frac{3}{2} \times 4.9073 = 18.4024$ miles

per second. There are 31,558,149 seconds in a year; therefore the sun's distance is $18.4024 \times 31,558,149 \div 2\pi = 92,428,300$ miles.

The sun can be weighed by its musical rhythm, with a corresponding facility. Orbital velocities vary inversely as the square root of the distance from the centre of gravity. Any two attracting masses bear the same ratio to each other as the distances at which they would communicate equal orbital velocities, to particles which revolve about the centre of gravity of the attracting bodies. Hence we have

$$\begin{array}{cc} \text{Earth's rad. vec.} & \text{Earth's rad.} \\ 92428300 \times (\frac{5}{2} \times \frac{3}{2})^2 : 3962.8 :: 327994 : 1. \end{array}$$

In other words, the sun weighs 327994 times as much as the earth.

There are many other harmonic tendencies, which are introduced by the masses and distances of other planets, as well as by the correlations of electrical, chemical, and other forces, which may slightly modify these estimates. There is, however, no likelihood that the adjustments of universal equilibrium would make a secular variation of $\frac{1}{2}$ per cent. in the earth's mean distance from the sun, and there has never yet been any astronomical estimate of that distance which has so small a probability of error as the one here given.

Injurious Effects of Illuminating Gas.—Dr. Arnozan recounts many accidents, which have fallen under his observation, among persons who have used gas for cooking. These accidents, which are almost always of a medical character, are especially frequent when the gas is burned in portable furnaces, which are not provided with a suitable chimney for carrying off the products of combustion, or when the gas is allowed to remain in rubber tubes. The latter risk may be mostly avoided by shutting the gas off from the tubes whenever the apparatus is not in use; but even then the rubber wears away so rapidly as to require frequent replacement. Whenever gas is used for cooking it should always burn with a blue flame, as in the Bunsen burner, on account of neatness, economy and health. Unfortunately the combustion of the gas is usually very incomplete, on account of the deterioration, or the bad arrangement, of the apparatus. Generally, also, kitchens are badly ventilated. Some accidents are reported from burns occasioned by the explosion of a detonating mixture at the moment when the gas is turned on.—*Génie Civil*.; *Les Mondes*, Feb. 2, 1884.