APPARATUS FOR COMPOUNDING RECTANGULAR VIBRATIONS.

BY GEO. M. HOPKINS.

The compound pendulum illustrated by the annexed engraving has advantages over those of the usual form, in being adapted to the ordinary horizontal lantern and in being less cumbersome and more easily managed. Perhaps the most important difference between this and other instruments of its class lies in the tracing arm and point. With this apparatus the beautiful curves of Lissajous appear on the screen, while the arm that traces them is invisible. With densely smoked glass this feature is not so apparent, but when colored collodion tracing films are used, it is a novel sight to witness the development of these intricate figures by a point having no apparent support or guide.

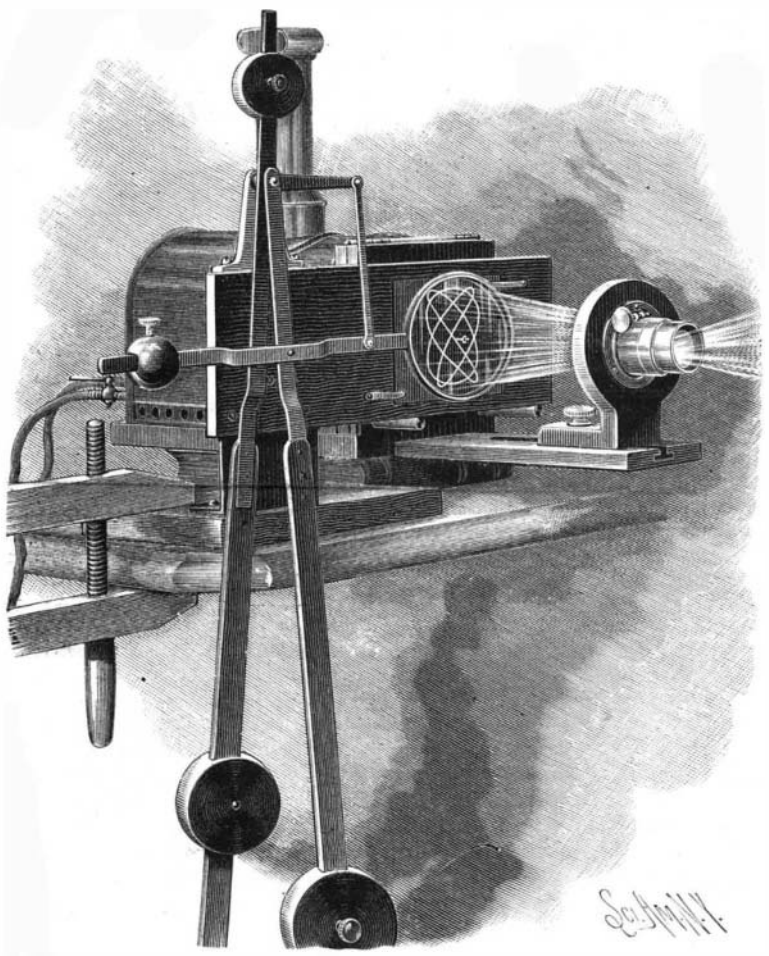
An apertured board having a recess for receiving the prepared glass plate forms the body of the apparatus. This board is connected by an iron standard with a base piece which is clamped to the lantern table in the manner shown. To the upper edge of the board is secured an arm provided with a horizontal stud upon which are pivoted two pendulums. The rear pendulum is prolonged above its pivot, and is provided with a right angled arm projecting toward the lantern, parallel with the back board. The upper end of the rear pendulum is provided with two or three interchangeable weights, varying from two to six pounds, and the lower end is provided with a movable weight of twelve pounds. The front pendulum is suspended from the same pivot, and is also furnished with a movable twelve pound weight. To the rod of the front pendulum is pivoted an offset bar, provided at one end with an annular frame containing a transparent glass disk and having at the opposite end an adjustable counterbalance weight. The glass disk is provided with a small central aperture, in which is inserted a fine needle. To the offset bar, half way between its connection with the pendulum rod and the needle, is pivoted a rod which is pivotally connected with the horizontal arm of the rear pendulum.

The offset bar is made of thin spring material, and is bent so that the needle presses lightly upon the prepared glass held in the recess of the back board. The prepared glass plate is retained in the position of use by two spring clips pivoted to the back board and arranged to press upon diagonally opposite corners of the glass. The needle is held away from the glass while starting the pendulum, by means of a thread (not shown) attached to the annular frame and connected with a fixed support in front of the frame and distant about a foot.

The adjustment of the weights for the different figures is ascertained by experiment, and the position of the weights is accurately indicated on the pendulum rods. The apparatus is placed in position on the table and the lantern is adjusted to it.

The colored collodion for the films is prepared by thinning ordinary plain collodion with alcohol diluted with water, then adding to it an alcoholic solution of aniline of any desired color. The glass plate is prepared for use by flowing the collodion over it and allowing it to dry. If the film proves too hard and tough, it may be modified by adding a small quantity of water to the collodion. This film gives a uniform tint on the screen and is dense enough to clearly show the lines of the tracing.

After the tracing point has been drawn back in the manner described, and the prepared glass plate is in place, the pendulums are drawn aside and the rear one is released. At a certain phase of its vibration (which will be determined by experiment) the front pendulum is released. If the needle describes the desired curve, the annular frame is released, when the needle traces the figure which appears upon the screen.



COMPOUND PENDULUM.

Prison Labor Contracts.

A very excellent suggestion has been made, which, if carried out, would tend to do away with much of the opposition to prison labor that is expressed by workmen. It is that the prisoners should be kept at work upon diversified industries. Thus the shoe manufacturer would experience no tangible competition, and the foundryman would not have the somewhat just grounds for complaint which have been afforded him in the past. The proposed system would be beneficial in all save one aspect. It would prevent the prison labor from being so profitable as it is now. But as prisons should be conducted for the protection of the community and reformation of the criminal, such a consideration is of very little weight. The various lines of industry would be adapted to the different intelligences of the convict, and when he left the prison the trade learned there would not be branded as a "State prison trade."

Harvard College Observatory.

From the recent annual report of Professor Edward C. Pickering we glean the following:

The photographs required for the second investigation on the spectra of the fainter stars would probably now be completed, at least for the northern stars, but for the unusual cloudiness of the last few months. It is expected to complete them during the coming winter, and then to send the instrument (the eight inch Bache telescope) to Peru, where both the investigations named above will be extended to the southern stars, thus rendering them complete for the entire sky. The detailed study of the spectra of the brighter stars with the eleven inch Draper telescope has been extended by the use of plates stained with erythrosin. The sodium line D in these spectra has thus been photographed as a double line. A catalogue has been formed of the lines in some of the brighter stars. In Sirius the lines, except those due to hydrogen, are very faint. But nearly four hundred of them have been measured in different photographs of this star. Fifteen are recorded between the lines H and K. A beginning has been made of the study of the spectra of the variable stars, but this work can probably be better done with the twenty-eight inch mirror. The latter instrument is now mounted, and experiments have been in progress with it for several months. The images show good definition, but the apparatus for producing the spectra has not yet given entirely satisfactory results.

The investigation of the clearness and steadiness of the air at Cambridge has been continued by the photographic methods mentioned in the last report. These are as follows: Photographs of the trails of the spectra of bright stars, photographs of the trails of stars near the North Pole and near the horizon, and photographs of the sky at different distances from the sun. The thirteen inch and eight inch telescopes mentioned in the last report were mounted early in the year, and the first of these instruments has been kept in nearly constant use since then. Eleven hundred photographs have been taken of a variety of objects to show what results may be expected under the atmospheric conditions existing at Cambridge.

Photographs have been taken of 112 double stars whose components are two seconds or more apart, and either of them as bright as the seventh magnitude. The relative brightness of the components will be determined, as well as their positions. The stars have also been allowed to trail over the plate, and this gives an excellent test of the steadiness of the air. Among other investigations made with this instrument are the determination of the actinic albedos of the moon and planets and the absorption toward the limb of the planet Jupiter. Photographs were obtained of the outer satellite of Mars, and of all the satellites of Saturn and Uranus except Mimas. It was shown that no undiscovered satellite of Saturn existed revolving in an orbit between Enceladus and Iapetus, unless it was more than a magnitude fainter than Hyperion. Probably no such satellite exists outside of Iapetus. Charts were constructed of the region near the North Pole, of the Pleiades, and of some other clusters and nebulæ. A study was also made of various lenses for enlargements and of various camera lenses. Sundry other photographic investigations have also been carried on. The total number of photographs taken in this department of the observatory during the year is about thirty-five hundred.

A Railway Tunnel between the United States and Canada.

Preparations are now being made on both sides of the river to recommence work on the great railroad tunnel under the St. Clair River at Port Huron. Early last year considerable preliminary work was done and $125,000 was expended; but, after two or three months, work was suspended, and has remained in that condition ever since. It was found that the sinking of shafts on the bank of the river on either side presented a great many difficulties, and finally the Grand Trunk Railway Company took the work out of the hands of Sooy Smith & Co., of New York, the contractors, and decided to take charge of the project itself.

Now, after looking the ground over, the company has decided to go back from the river some distance and commence work on the tunnel proper. The work of excavation on the American side will begin about 2,500 feet back from the river, and from this point there will be a steady decline till the necessary depth under the bottom of the river, about 50 feet, is reached. The drift for the tunnel proper will be 22 feet in diameter, and the distance from one river bank to the other is 2,200 feet. The tunnel will have a drop of 90 feet to the mile, the lowest end being on the Canadian side.

The work of excavating in the tunnel will be done with large steel "shields," 22 feet in diameter. These shields will be driven into the earth with 24 hydraulic jacks, each with a pushing force of 125,000 pounds. A large hydraulic engine will be used to work the jacks. Five railway tracks for small trucks will be laid in the bottom of the tunnel, and as fast as the earth is excavated it will be loaded on these trucks, which are each capable of holding two cubic yards. A cable running from a large hoist engine through the tunnel to the cars will pull them up to the surface, where the dirt will be loaded into other cars to be carried away.

As the earth in the tunnel is removed a gang of men will follow with the lining of the tunnel, which is cast iron. The tunnel will thus be completed as the work progresses. A monster blower engine is suitably situated to force air into the tunnel through a 24 inch pipe. A large electric light engine will furnish 300 lights, and it is proposed to make the interior of the tunnel as light as day. A force of 125 men will be employed on each side of the river, and the work will be pushed night and day.

It is expected that the workmen from each side will come together about 700 feet from the Canadian side. The approach to the river is nearly a mile longer on the Canadian side than on the American, as the up grade is all on the land side in Canada. The approaches will not be tunneled until the tunnel under the river is completed. The tunnel, as finished, will consist of 2,500 feet on the American side, 2,200 under the river, and 4,000 feet on the Canadian side. There are now at work 125 men on the Canadian side and 60 on the American side. Another large addition was made to the working force January 2, when active operations were begun, and they will be vigorously pushed henceforth, it is asserted.

It is estimated that the work will cost $2,500,000, although well-informed men predict that it will cost nearer $5,000,000. President Sir Henry Tyler and Manager Hickson have been heard to remark that it will be completed if it costs $10,000,000.—*N. Y. Times.*

Copyright in Judicial Opinions.

The Supreme Court of the United States has rendered a decision in reference to the copyrighting of judicial opinions, in the case of Callaghan *et al. vs.* Myers. The appellee brought suit against the appellants for infringing upon a copyright secured to him by the reporter of the Supreme Court of Illinois by publishing certain volumes of the Illinois reports. The court decided in favor of the appellee, holding that while copyright cannot be secured for the text of the opinions of the judges, the reporter of the court has the right, in the absence of any legislation forbidding him to do so, to secure a copyright for the title, headings, notes, syllabi, and arrangement of the opinions, and that as the book would be of no value without these copyrighted portions, the whole book may be copyrighted. The court, said, however, that this copyright will not hold good where it is sought to be procured in behalf of the State.

THE secrets of much success in this world are cash, confidence, cheerfulness, and constancy.